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Sewing-knitting Machines MALIMO

Technical Possibilities and Technology

Part 1: Technical possibilities and technology of type Malimo

Part 2: Textile-technological possibilities of type Malimo

Part 3: Technical possibilities and technology of type Schusspol

Part 4: Technical possibilities and technology of types Maliwatt and Malivlies

Part 5: Technical possibilities and technology of type Malipol

Part 6: Technical possibilities and technology of type Voltex

Part 1
Technical possibilities and technology of type Malimo

0. Introduction

The MALIMO sewing-knitting technique fascinates every expert by the comprehensiveness of its technological applicability. About 60 per cent of all sewing-knitting machines manufactured so far are of the type Malimo. The amazing thing about it is that nearly all fibres and extreme yarn counts can be worked up. The fabrics formed on sewing-knitting machines type Malimo can both consist of 100 per cent filament yarn yielding fabric weights of 80 to 90 g/m^2 and of spun yarns yielding fabric weights between 600 and 700 g/m^{2HX}. As a matter of course, all intermediate grades can be formed. To assist in selecting from the great variety the optimum conditions for the article to be produced, or the material to be worked up, the technical possibilities are outlined in the following.

1. Mode of operation of the sewing-knitting machine MALIMO type Malimo

1.1. Arrangement of the stitching area

The sewing-knitting machine MALIMO type Malimo is used for the production of a stitch-bonded fabric. As a rule, two superimposed yarn layers, the warp layer and the weft layer, are joined to each other by a third yarn element, the stitching yarn, to yield a textile fabric.

Fig. 1 shows the arrangement of the working area of this type of machine.

The pointed stitching or sliding needle (Fig. 2) particularly developed for the sewing-knitting technique works together with a closing wire which reciprocates in a groove in the needle shaft and effects the closing or opening of the opentype eye of the needle. In the machines of the gauge 22 F an angled sliding needle is used.

The sliding needles emerge from between the knocking-over sinkers and pierce the fed-in yarn layers. The stitching yarn guides lap the stitching yarn over the breast of the sliding needles. As the sliding needles retract, the stitching yarn slides into the open eyes of the sliding needles. At the same time the closing wires are advanced and close the eyes of the sliding needles where the stitching yarn is retained. In this relative position the sliding needles and their associated closing wires are retracted at a time through the medium to be bonded. During this operation, the semistitches formed in the preceding cycle and hanging on the needle shafts are stripped off by the knocking-over sinkers and are converted into stitches.

Before the next stitch forming cycle is started, the semistitches retained in the needle eyes are pushed trough the yarn layers in front of them on to the needle shafts, as the sliding needles are advanced. The retaining pins and the retaining bar prevent that loops or yarn layers are advanced due to friction.

All stitch-bonding elements illustrated in Fig. 1 with the exception of the retaining bar are mounted group-wise according to the gauge of the machine in leads 25 mm wide. These leaded units are screwed to a bar and can be easily exchanged.

The sewing-knitting technique utilizes the interlocking chain stitch and the plain chain stitch which are well known in warp knitting. The following movements are performed by the movable bars which include the sliding needle bar, the closing wire bar, and the stitching guide bar.

- The sliding needle bar and the closing wire bar perform a lifting stroke.
- The stitching guide bar performs a swinging movement and an alternating movement. At plain chain stitch where one stitching yarn guide works together with ever the same sliding needle the movement is nearly circular.
- At interlocking chain stitch where one stitching yarn guide works alternately together with the sliding needles the movement resembles a lying eight.

The stitch-bonding elements are driven through crank mechanisms running in an oil bath in enclosed gear boxes. The movement of the bars is derived from eccentrics which can be easily exchanged. The gearing for the alternating motion can be adjusted at option for interlocking chain stitch, or for plain chain stitch.

1.2. Yarn feeding

1.2.1. Stitching yarn feeding

The stitching yarn is supplied to the machine from beams. For small working widths and coarse machine gauges magazine creels can be used.

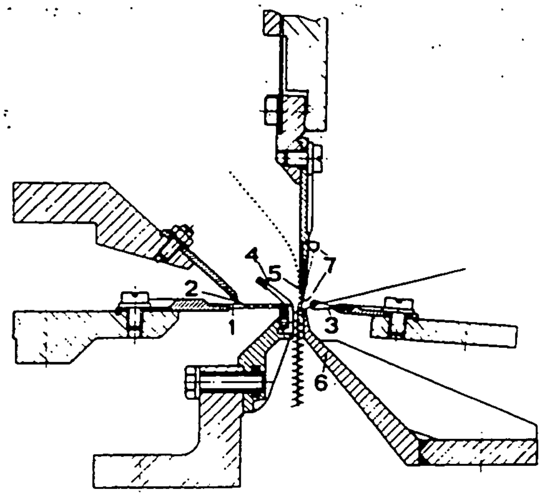
The beams consist of tubular steel 152 mm in diameter and have flanges of light metal. The flanges are 600 or 800 mm in diameter. Sectional beams can also be used. For working up man-made filament yarns special beams are supplied.

The number of stitching yarns required is calculated from the working width and the gauge of the machine. When interlocking chain stitch is used the outermost yarn must be drawn from bobbins, because take-up is smaller in the edge yarns.

The stitching yarn beam is supported in a beam running-off stand arranged in front of the machine. To keep the yarn tension constant over the entire length of the yarn being fed into the machine the braking force required for the beam must be varied as the diameter of the beam decreases. Supervision of the yarn tension is aided by a tension indicator arranged on the beam stand. In Fig. 3 the passage of the yarn and the fabric in the sewing-knitting machine type Malimo is shown.

The sheet of stiching yarns is drawn from the beam, guided by several yarn guiding plates and deflecting rolls, and is passed through the tension indicator on the beam running-off stand, underneath the operator's stand, through the yarn feeding device, the yarn tensioner and the yarn stop motion to the stitching yarn guide bar.

The yarn feeding device consists of two smooth rollers driven through an infinitely variable drive. The principle underlying the feeding of the yarn is that of rope friction. The wrapping



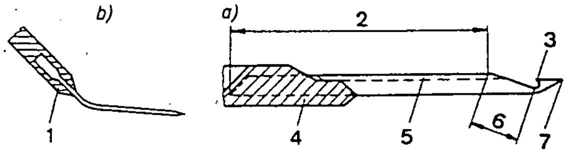


Fig. 1 Arrangement of the stitching area of a MALIMO sewing-knitting machine type Malimo

1 Sliding needle
2 Closing wire
3 Knocking-over sinker
4 Supporting rail
5a Retaining pin
6a 1st guide bar

Fig. 2 Sliding needle a and its associated closing wire b

1 Lead
2 Shaft
3 Groove
4 Breast
5 Hook
6 Point

Fig 3 Schematic diagram of yarn and cloth passages in a MALIMO sewing-knitting machine type Malimo

1 Stitching yarn beam
2 Warp beam
3 Stitching yarn
4 Warps
5 Weft yarn
6 Stitch-bonded fabric
7 Fabric winding-up device or
8 Fabric plaiter

angle on both rollers is 180°. This type of yarn feeding device enables the optimum yarn tension to be set during machine operation. The machine can also be equipped with two yarn feeding devices.

The yarn tensioner has been developed to compensate for variations in yarn demand during the loop-forming process. The tensioner consists of spring-clamped plates over which the stitching yarn is passed. The springiness is to be adjusted in accordance with the type of yarn used.

The drop wire yarn stop motion operates on the basis of electronic supervision. The stitching yarn is supervised by drop wires working together with a control rail. In case of yarn breakage the drop wire drops, and but a short contact between the control rail and the drop wire suffices to stop the machine.

The very short response time of this type of stop motion device in combination with a strong machine brake ensures short stopping times. Signal lamps assist in finding out the brocken end.

1.2.2. Weft feeding

The weft yarn is supplied to the machine from bobbins. The bobbins are crealed on magazine creels with a total of 144 creeling points. The creels are arranged at the left and the right of the machine.

The yarns are withdrawn over-end. Conical cross-wound bobbins with a conicity of 9°15′ have proved best for this purpose. Special constructions of the weft yarn creels enable SZ cops and coarse yarns to be worked up (Table 1).

The weft yarns are passed through self-cleaning disk brakes and through a yarn guide plate arranged on top of the creel. From there, the yarns enter the superstructure of the machine. In the machine, the yarns are passed through an electromechanical stop motion device, a yarn tensioner, and are threaded from above into the weft carrier. The weft carrier carries the weft yarns from one side of the machine to the other. On reversal of travel the yarns are passed through guide plates into the spaces between the hook needles. The hook needles resemble small hooks and are group-wise mounted in leads.

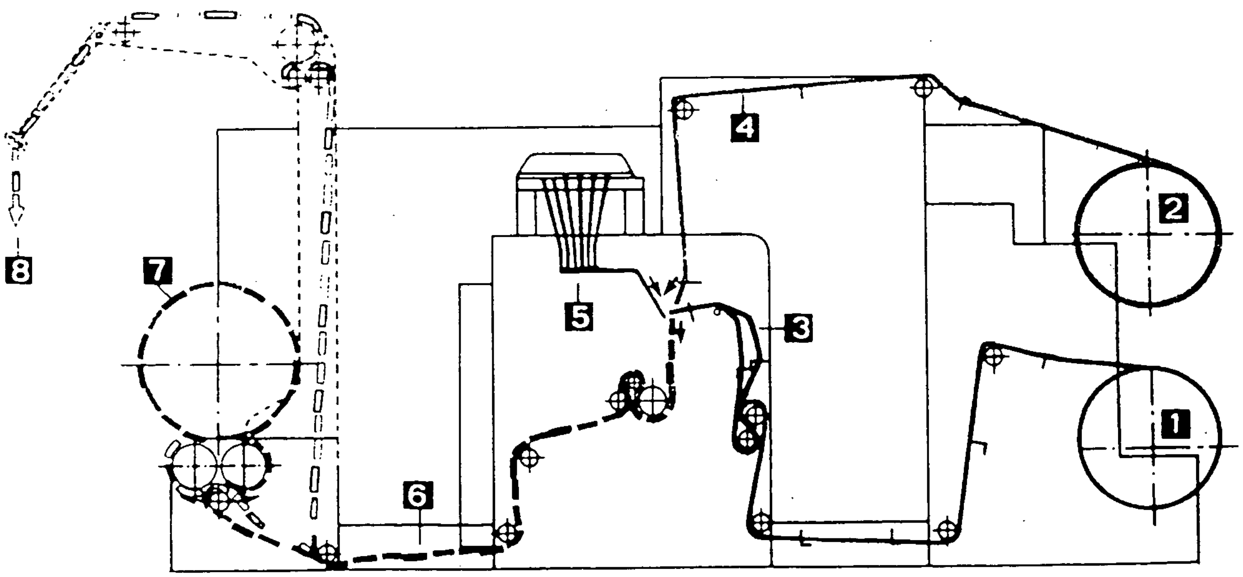


Table 1 Weft bobbin creel

	a) Standard design for conical cross-wound bobbins	b) Special design for SZ cops	c) Special design for coarse yarns
Winding-off points/creel	72	72	21
Gauge of creel, in mm	185	190	270
Maximum length of tubes, in mm	190	465	250
Optimum half cone angle	9°15'	–	2°30'
Yarn tensioner	self-cleaning disk-type tensioner	plate-type tensioner with sintered corundum pins	self-cleaning disk-type tensioner
Skewering peg	special design for all cone angles	pegs	special design for all cone angles
Creel	magazine creel	magazine creel	magazin creel

Multiple-roller chains on which the hook needle units are fixed carry the weft yarns to the stitching area. The hook needle chains move at constant speed in compliance with the stitch length and speed setting. At a moment of rest on the reversal of travel of the weft carrier the weft yarns placed into the spaces between the hooks can sling around one or more hook needles. The continuous movement of the hook needle chains ensures that the weft yarns are laid down in a zig-zag type pattern (Fig. 4).

To warrant that the sheet of weft yarns is laid down close to the preceding yarns so that no gap can form, a certain number of yarns is to be threaded through the weft carrier reeds in dependence upon the stitch length, the weft carrier travelling speed, and the gauge of the hook needle units. The laying angle of the weft yarns with respect to each other can be varied by changing the weft carrier travelling speed in dependence upon the laying width.

Weft carrier reeds and hook needle units are available in a variety of gauges and makes. The reeds of the weft carrier come in three types:

1. Symmetrical separator-type reeds. Here, the reeds are so composed of symmetrical separators that the gauge of the yarn threading spaces for the sheet of weft yarns to be threaded on the right and the left side corresponds to the gauge of the yarn outlet.
2. Asymmetrical separator-type reeds. The reeds are so composed of asymmetrical separators in a staggered arrangement that the gauge of the yarn threading spaces for the sheet of weft yarns to be threaded on the right and the left side corresponds to half the gauge of the yarn outlet.
3. U-shaped reeds. Here, the reeds come in the form of a U-bow with bore holes through which the individual weft threads are threaded. This type of reed ensures perfect outlet of yarn and is especially used for fine-count weft yarns.

The type of reed to be selected depends upon the weft yarn to be worked up and, to a large extent, upon customer's desire.

1.2.3. Warp feeding

The system of warp yarns can be omitted at option. When warps are used, these are usually worked off from beams as the stitching yarn is. The sheet of warps is passed through several yarn guide plates and reversing rollers to the operator's stand and is fed from above into the stitching area.

The hanging of the warps into hooks and warp guides which are combined with retaining pins ensures for the warps to be fed in compliance with the gauge into the stitching area.

A yarn breakage detection system is not required for the warp yarn system, because the warps are much less stressed than the other yarn systems are. However, a warp stop motion device can be attached upon request.

1.3. Fabric take-up device

The different ways of guiding the fabric are illustrated in Fig. 3. The fabric take-up proper in the form of the fabric take-up rolls is arranged underneath the stitching area. The rolls are covered with a rough material and take up the cloth by friction. The gearing of the fabric take-up is also used for the regulation of the stitch length.

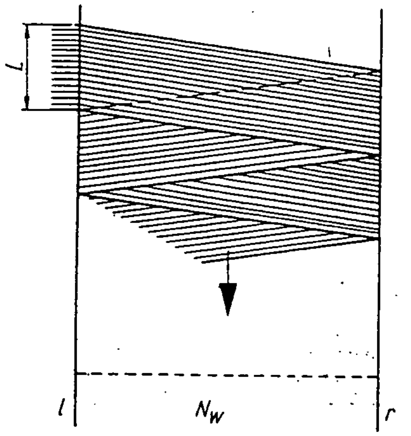


Fig. 4 Positioning of the sheet of weft yarns.
l Left-hand weft hook chain
r Right-hand weft hook chain
Nw Stitching area.

The cloth is delivered in one of the following ways:

1. A fabric winding-up device is supplied as standard. It is operated according to the raising-roller principle and can take-up rolls up to 1200 mm in diameter.
2. A fabric plaiting device can be supplied which enables the cloth to be plaited down on to pallets, trucks, or special tables.
3. A combination of the first two variants can be supplied, the fabric plaiter being driven through the take-up roller of the machine.

With the aid of change gears the proper draft between the machine and the fabric delivering device can be adjusted over a range between + 10 and – 12 %.

2. Designation of gauge of the MALIMO sewing-knitting machine type Malimo

2.1. Gauge of the machine

The gauge of the machine is established from the number of stitch-bonding elements to 25 mm. The symbol is F.

Over the entire range of gauges stitch-bonding elements different in dimensions are used to warrant the greatest possible safety in the working-up of certain types of yarn and to obtain a perfect appearance of the fabric produced. These stitch-bonding elements include the sliding needle, closing wire, stitching yarn guide, retaining pin, knockingover sinker, and the hook needle.

A classification of the different types of needles is compiled in Table 3.

In order to form, with the various needle types, fabrics in a range of different fabric weights, sliding needle units can be made for the following lengths of stroke: 10 mm, 12 mm, 17 mm and 24 mm. If a length of stroke between every two of those stated is selected, the sliding needle unit destined for the larger stroke should be used: e. g., for a length of stroke of 15 mm the sliding needle unit for 17 mm length of stroke should be used. The 10 mm stroke should be reserved for the very fine (sf) sliding needle. For the fine (f) sliding needle the 12 mm stroke, and for the medium (m) sliding needle the 15 and 17 mm strokes, at option, are provided. For the coarse (g) sliding needle the 17 and 24 mm strokes, at option, are provided. The stroke of the closing wire units is to be adapted to the stroke of the sliding needle in dependence upon the machine setting and the yarns to be worked up. Closing wire units can be made for the following lengths of stroke: 8; 9.6; 13.6; and 17 mm.

2.2. Gauge of the weft carrier reeds

The character of a stitch-bonded fabric is mainly determined by the gauge of the machine. Consequently, when the type of weft yarn to be used is selected the sliding needle to be used must be considered alike. To meet this requirement to the largest possible extent the reeds of the weft carrier, too, come in a variety of gauges. The gauge E of the weft carrier reed is determined by the number of weft yarn outlets per inch (24.5 mm). The reeds of the weft carrier come in the following gauges: 4 E; 4.5 E; 5 E; 5.5 E; 8 E; 10 E; 11 E; 12 E; 16 E; 20 E; 22 E; 24 E and 32 E.

Through each yarn outlet one weft end, or several weft ends at a time, can be threaded. This materially influences the character of the fabric to be formed. Therefore, an advantageous ratio between the cross-sectional volume of the yarn and the clear opening of the yarn outlet should be observed as the type of weft yarn is selected. The ratio is advantageous when both the weft yarn and the tied-up places in the yarn can be easily passed through the outlet opening, and when the spaces between the neighbouring yarns are kept equal. The width of a weft carrier reed is 6.5 inches (165 mm), or 4.5 inches (114.5 mm). This gives a theoretical number of 26 weft yarns at 4 E, and 208 weft yarns at 32 E.

Table 2 Gauges of sewing-knitting machines

Gauge		corresponds to	Centre distance
3	F		8.333 mm
3.5	F		7.142 mm
4	F		6.250 mm
5	F		5.000 mm
6	F		4.166 mm
7	F		3.571 mm
8	F		3.125 mm
10	F		2.500 mm
12	F		2.083 mm
14	F		1.785 mm
18	F	frequent in use	1.388 mm
22	F		1.136 mm

Table 3 Kinds of needle

		Length of point	Thickness	Height of shaft
Sliding needle	coarse (g)	3.7 mm	1.2 mm	2.7 mm
	medium (m)	3.2 mm	0.9 mm	2.0 mm
	fine (f)	2.2 mm	0.6 mm	1.5 mm
	very fine (sf)	1.5 mm	0.52 mm	1.3 mm
Closing wire	coarse (g)		0.56 mm	
	medium (m)		0.46 mm	
	fine (f)		0.25	
	very fine (sf)		0.22 mm	

The closing wire unit must always correspond to the sliding needle.

Stitching yarn guide	Stitching yarn guide diameter	1.6 mm 1.8 mm 2.5 mm 3.3 mm
Retaining pin	Thickness	0.25/0.6 mm oval 0.35/0.6 mm oval 0.75 mm round 0.46/0.75 mm oval
Sliding needle		to be used for gauges
g		3.5 to 8 F
m		3.5 to 14 F
f		3.5 to 18 F
sf		22 F

2.3. Hook needle units

The gauge of the hook needle units is adjusted to match the gauge of the weft carrier reed. The gauge of the hook needle units, which are 12.7 mm wide, stands for the number of hook needles per half an inch (12.7 mm). Hook needle units come in the following gauges: 4; 5; 6; 8; 10; 11; 12; 16; 24.

Height of hook:

Gauge 4; 5; 6; 8;	5 mm or 7 mm	(wire gauge)
10	5 mm	(wire gauge 0.75 mm)
10; 11; 12; 16:	4 mm	(wire gauge 0.35 × 0.6 mm)
20; 24:	4 mm	(wire gauge 0.25 × 0.6 mm)

2.4. Yarn finenesses

Owing to the many stitch-bonding elements available in sewing-knitting machines the most different types of yarn can be combined to form a stitch-bonded fabric. According to this, the range of types of stitch-bonded fabrics is very large, and so are their ranges of application. Therefore, basic ranges of yarn counts with regard to the individual stitch-bonding elements are difficult to establish, and the counts mentioned in the following should be considered a rough guide only. Provided that they cover yarns included in the usual production of the spinners, these counts are expected at a high degree of probability to yield a perfect fabric.

For the stitching system, yarns up to 6.8 tex (Nm 147.1) are workable if the fine or very fine sliding needle is used. The lower limit is 14.3 tex (Nm 70) for the very fine sliding needle, and 35.5 tex (28.22) for the fine sliding needle. For these yarn counts a stitching thread guide with an eye 1.8 mm in diameter is recommended, and 1.6 mm if the very fine sliding needle is used.

If the medium sliding needle is used, the stitching yarn should not exceed 143 tex (Nm 7). In this case, a stitching yarn guide with an eye 2.5 or 3.3 mm in diameter should be used according to the surface of the yarn.

The coarse sliding needle can work-up yarn counts up to 330 tex (Nm 3.024). These yarns require a stitching yarn guide with an eye 3.3 mm in diameter.

The count of the warps should be so that after addition of the gauge of the sliding needle the gauge of the machine is not exceeded.

The count of the weft yarn can be 500 tex (Nm 2), if hook needles 0.75 mm in diameter and 7 mm high are used. However, such thick yarns may happen to be pierced by the sliding needle, which particularly depends on the type of the sliding needle used and the stitch length adjusted. The thickness of the weft yarns can also govern the selection of the stroke of the sliding needle.

3. Specifications of the MALIMO sewing-knitting machine type Malimo

3.1. Nominal width

Sewing-knitting machines type Malimo come in widths ranging from N 1000 through N 1600 to N 2400. These nominal widths can be adjusted in increments of 25 mm to give the desired working width:

Nominal width N 1600 – working width adjustable - between 1050 and 1600 mm
Nominal width N 2400 – working width adjustable - between 1650 and 2400 mm

If the working width is varied, the retaining bar must be replaced in accordance with the new working width. All other parts of the machine need not be replaced if the working width is changed; i.e. they can be adjusted according to the width desired.

Each working width within the nominal width can be adjusted for every gauge covered by the production programme. For this purpose, the eccentrics that correspond to the respective gauge must be mounted.

3.2. Performance data

3.2.1. Speed

The speed of the machine is neither conditioned by the gauge nor by the width of the machine, but is usually determined by the type of the yarn to be worked up and the construction of the fabric to be formed. The speed is infinitely variable and can be adjusted as follows.

For N 1600, and N 2400;

- between 500 and 1500 r.p.m. at gauges 3 to 18 F, and
- between 500 and 1600 r.p.m. at gauge 22 F.

Besides the speed, the efficiency and the stitch length are decisive for the determination of the output of a MALIMO sewing-knitting machine type Malimo.

3.2.2. Efficiency

The efficiency depends on the material to be worked up. If fine yarns are used which are strong enough to permit the forming of a faultless fabric, efficiency increases owing to the longer thread lengths beamed. With very coarse yarns to be worked up the down-times for preparation and auxiliary jobs are long, whereby efficiency is affected. Under advantageous conditions efficiency can range between 75 and 80 per cent.

3.2.3. Stitch length

The stitch length can be adjusted in 20 steps within a range between 0.7 and 5 mm. Change gears are used to vary the stitch length. At gauge 22 F, stitch lengths within a range between 0.55 and 2.00 mm can be attained.

The stitch length indicates the distance between the course already knitted and the following one. In a stitch-bonded fabric it appears in the form of the size of a loop and as such it can be measured.

At the same speed, the output of a sewing-knitting machine increases as the stitch length increases. To obtain a wel-closed surface of the fabric, the following stitch lengths should

be preferably applied:
1.3 to 3.0 mm at gauges 3.5 F to 14 F
0.9 to 2.0 mm at gauge 18 F
0.6 to 1.2 mm at gauge 22 F.

3.3. Connected load and floor space requirements

The connected load for N 1600 is some 4.5 kW, while 6.0 kW are required for N 2400. The floor space required for the installation of a complete sewing-knitting machine is 25 m² for N 1000; 33 m² for N 1600; and 38 m² for N 2400.

4. Attachments to MALIMO sewing-knitting machines type Malimo

The wide range of applications led to special demands to be made on the machines, and to the development of attachments. Sewing-knitting machines type Malimo can be supplemented by the following attachments: Backing cloth feeding attachments, separator, point ionizer, warp alternating motion, and separate warp guide bar.
The attachments mentioned can be mounted to the machine both by the manufacturer VEB Nähwirkmaschinenbau MALIMO and, later on, by the user.

4.1. Backing cloth feeding device

The backing cloth feeding device for Malimo machines permits the additional feeding of backing fabrics of all kinds, such as woven fabric, bonded fabric, etc.
The backing fabric is fed to the stitching area through a temple arranged underneath the weft yarn layers. The backing fabric is to be supplied in the form of rolls, the diameter not exceeding 500 mm.
The attachment for the feeding of the backing cloth is a prerequisite for the forming of pile fabrics and the development of MALIMO corduroys.

4.2. Slitting device

The stitch-bonded fabric can be slit in machine direction with the aid of circular and traversing cutters to obtain stripes of any width desired which can preferably be used in the field of industrial textiles (bituminous bandages). The fabric is slit short of the fabric roll-up device.

4.3. Point ionizer

It is advisable to use point ionizers to eliminate electrostatic charges, if man-made continuous filament yarns are worked up. The point ionizers can be arranged underneath the weft yarn layer, in front of the stitching yarn tensioners, or in front of the last warp guide plate. This will enable man-made continuous filament yarns which are prone to electrostatic charging to be satisfactorily worked up without previous application of an anti-static finish.

4.4. Warp alternating motion

The alternating motion is used to achieve additional patterning mainly in sinusoidal form, or in a combination of the latter with a straight line, by the lapping of patterning warps which are separately fed. The patterning warps are lapped through two tube bars racking laterally and driven through chain links or disk control. The feeding and racking of patterning warps occurs between the laying down of the weft yarns and the feeding of the basic warps.

4.5. Separate warp guide bar

For the working-up of extremely thick warp yarns it is advisable to use a separate warp guide bar. The sturdy warp guides permit the working-up of coarser ends. If the eyes of the warp guides are too small, these can be closed with steel wire across the entire bar, and the warps are then fed behind the wire and between the warp guides into the stitching area. This method is especially advisable for the production of industrial textiles (protectors against puncture) and if glass and asbestos yarns are worked up. The warp guide bar is arranged on the T-beam above the retaining pin units.

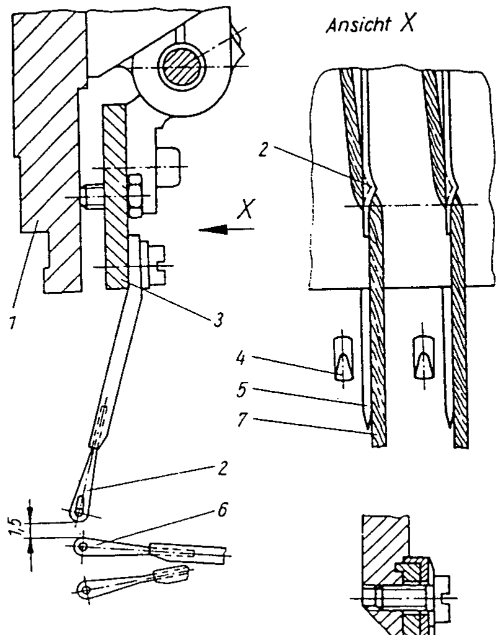


Fig. 5 Warp guide bar
1 Bracket
2 Warp guide
3 Warp guide bar
4 Sliding needle
5 Retaining pin
6 Stitching yarn guide in topmost position
7 Warp
8 View X

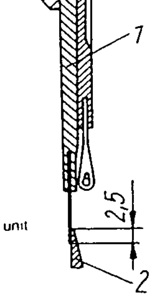


Fig. 6 1 Warp guide and retaining pin combination unit
2 Retaining bar

1. Range and essential features of application

A great variety of sewing-knitting machines MALIMO type Malimo have been developed for many different end-uses and are constructed for them accordingly. Within the four main ranges of application indicated in Table 1 a great number of groups of articles and individual articles have been developed and produced with due consideration given to the optimum machine gauge, technological parameters, and types of yarn. The construction of the desired kind of stitch-bonded fabric requires for the following factors to be observed to obtain the optimum product parameters at economic production:

1. Fabric weight per unit area
2. Kind of fibres to be worked up
3. Strength requirements and dimensional stability to be met by the fabric counting in the finishing techniques
4. Design of the face of the fabric, selection of the yarn counts for the different yarn systems, selection of stitch length
5. Patterning of the fabric to be formed; imparting the fabric certain properties by subsequent processing and finishing

The theoretical determination of some essential features of fabric construction of Malimo fabrics are discussed later on.

1.1. Drapery and home furnishing materials

In Tables 1 and 2 a range of products basing on an abundance of fabric constructions and technologies is compiled.

Recommendations for fabric designs within the range of drapery and home furnishing materials:

Preferred kinds of yarn:

- Stitching yarn: Polyacrylonitrile spun yarn, polyester spun yarn; viscose spun yarn; viscose continuous filament yarn; polyester continuous filament yarn.
  Yarn counts between 100 tex and 6.7 tex (Nm 10 to Nm 150)
- Warp yarn: All natural, regenerated, and man-made fibres in the form of spun yarn, twisted yarn, continuous filament yarn, and blends
  Yarn counts between 166.7 and 11.7 tex (Nm 6 to Nm 85) including fancy yarns
- Weft yarn As stated for warp yarn

Yarn counts for the individual sliding needle gauges:
Coarse needle: from 100 tex to 25 tex (Nm 10 to Nm 40)
Medium needle: from 50 tex to 10 tex (Nm 20 to Nm 100)
fine needle: from 25 tex to 6.7 tex (Nm 40 to Nm 150)
Very fine needle: from 16.7 tex to 6.7 tex (Nm 60 to Nm 150)
For the medium, fine, and very fine needle, yarn from 16.7 tex (Nm 60) in the form of continuous filament yarn.

When coarse patterning warps such as fancy yarns are worked up, a separate warp guide bar should be used (upholstery fabrics).

Fabric weights per unit area that can be produced in dependence on the article: Between 80 g/m^2 (curtains) and 500 g/m^2 (upholstery fabrics).

The usual stitch lengths are within 1 and 3 mm.

1.2. Household fabrics

Malimo fabrics are used for household fabrics in the applications as listed in Table 1.

The yarns preferred for these end-uses are spun yarns made of cotton, and spun yarns or continuous filament yarns made of regenerated fibres on viscose basis, and blends of these. The use of these fibres is conditioned by the care required by household textiles (washing at the boil). The finishing technology is to be selected accordingly, particularly with regard to dyeing and printing. The patterning effects that can be produced on the sewing-knitting machines type Malimo are achieved with the aid of patterning yarns different in colours, fancy yarns, and threading according to the design. Typical fabrics and their essential parameters are compiled in Table 2.

Preferred kinds of yarn:

- Stitching yarn: Cotton; viscose spun yarn; viscose spun yarn/cotton
  Yarn counts between 100 tex and 11.1 tex (Nm 10 to Nm 90)
- Warp yarn: Cotton; viscose spun yarn; viscose spun yarn/cotton; fancy yarn; mixed shoddy yarn
- Weft yarn: Cotton, viscose spun yarn; viscose spun yarn/cotton; fancy yarn; mixed shoddy yarn
  The stitching yarn requires careful preparation with regard to evenness and tieing the knots (weaver's knot)

Yarn counts for the individual sliding needle gauges;
Coarse needle: from 100 tex to 36 tex (Nm 10 to Nm 28)
Medium needle: from 50 tex to 25 tex (Nm 20 to Nm 40)
Fine needle: from 29 tex to 17 tex (Nm 34 to Nm 60)
Very fine: from 17 tex to 7.6 tex (Nm 60 to Nm 132)
continuous filament yarn)

The fabric weights per unit area can be selected to advantage to be within 120 g/m^2 and 350 g/m^2 in these applications. The preferred stitch lengths are within 1.3 mm and 2.5 mm.

Table 1 Range of application of Malimo stitch-bonded fabrics

Drapery and home furnishing materials	Household fabrics	Apparel fabrics stable, or partially elastic, or fully elastic	Industrial textiles
Drapery materials with closed face Curtains Wall covering material Upholstery fabrics Lamp shade materials Materials for blinds	Cleaning and polishing cloths Floorcloths Towels Dishcloths Dishtowels Bed sheets Baby-clothes Table linen Multi-purpose and camping clothes Aprons Babies' bibs and aprons Shopping bags	Blouse and dress materials Suitings and costume materials Jacket fabrics and trouserings Coatings Shirtings for leisure wear and dress shirts Beach and bath wear Leisure wear Children's clothing materials	Plies subjected to tension in conveyor belts Covers and protective inserts of conveyor belts Filter cloths Packing material Tarpaulins Coating backs for imitation leather Floor coverings

Table 2

Article	Yarn count in tex (Nm)					Fabric weight per unit area
	Stitching yarn	Warp yarn	Weft yarn	Machine gauge	Stich length mm	g/m^2
Drapery materials	17 (59) VI-S	50 (20) VI-F	30 (33) VI-F	18 F	1.4	220
Drapery materials	17 (59) PE-S	118 (8.5) PAN-F	71 (14) PAN-F	14 F	1.4	170
Semi-sheer draperies	8.4 (119) PE-S	125 (8) VI-S-t	143 (7) mixed shoddy yarn	14 F	1.4	115
Semi-sheer draperies	11 (91) PE-S	125 (8) × 2 PAN-F	125 (8) × 2 PAN-F 125 (8) PAN-F	10 F	2.25	150
Curtains	17 (59) PE-S	36 (28) × 2 PE-F	36 (28) × 2 PE-F 36 (28) PE-F			
			30 (33) VI-F	14 F	1.4	150
Blinds	17 (59) VI-S	–	25 (40) VI-F	22 F	1.1	140
Wall coverings	10 (100) PE-S	250 (4) VI-F 170 (5.8) VI-F 125 (8) VI-F	250 tex VI-F 170 tex VI-F 125 tex VI-F	10 F	2.8	320
Upholstery fabrics	34 (29) VI-S	4 (12) × 2 VI-F	84 (12) VI-F	14 F	1.8	350
Upholstery fabrics	21 (48) PAN-F	340 (3) fancy yarn 143 (7) × 3 PAN-F 143 (7) × 2 PAN-F	143 (7) mixed shoddy yarn	7 F	2.0	420

Table 3

Article	Yarn count in tex (Nm)					per unit area
	Stitching yarn	Warp yarn	Weft yarn	Machine gauge	Stitch length mm	g/m^2
Dishtowel	36 (28) VI-F/Bw	36 (28) VI-F/Bw	36 (28) VI-F/Bw	14 F	1.4	205
Bed sheet	25 (40) VI-F/Bw	30 (33) VI-F/Bw	36 (28) VI-F/Bw	18 F	1.5	215
Camping cloth	25 (40) VI-F/Bw	25 (40) VI-F/Bw	25 (40) VI-F/Bw	18 F	1.4	207
Dishcloth	36 (28) mixed shoddy	140 (7) mixed shoddy	140 (7) mixed shoddy	7 F	2.75	190

1.3. Apparel fabrics

Malimo apparel fabrics include any Malimo fabric directly used as a clothing material (Table 1).

The dimensionally stable and elastic fabrics and their surface structures can be typical Malimo, or resemble a woven or knitted structure, or possess their properties. Recently, an increased portion of Malimo stitch-bonded fabrics was made to resemble corduroy.

Care must be taken, however, that every article is made of the specific kind of yarn and at the technological parameters that correspond to the end-use of the fabric and the properties required (Table 4).

The range of workable textile raw material is nearly unlimited and covers all natural, regenerated and man-made fibres as well as their blends, including metal core yarns and twisted metal threads.

When new assortments of Malimo apparel fabrics are designed, the following factors should be observed.

- Machine gauge

For the production of apparel fabrics, the machine gauges 10 F to 22 F are used for the most part. Medium to heavy-weight fabrics are produced on the 14-gauge to the 10-gauge machines, light to medium-weight fabrics are produced on the 18-gauge to the 14-gauge machines, and very light-weight fabrics are made on the 22-gauge to the 18-gauge machines. Cotton-type apparel fabrics should preferably be made on the 18-gauge and 14-gauge machines.

- Stitch length

Products made on the 10-gauge machines are mainly formed at stitch lengths between 1.5 mm and 2.5 mm, while fabrics made on the 14-gauge machines are mostly formed at stitch lengths between 1.3 and 2 mm. For the 18-gauge machine stitch lengths between 0.8 and 1.5 mm should be analogously applied, and on the 22-gauge machine the fabric should mainly be formed at stitch lengths between 0.7 and 1.2 mm. The stitch lengths mentioned are the recommended ones for dimensionally stable structures in dependence on their characters. Occasionally, other stitch lengths, too, are used to produce special articles such as bonding upperwear which is partly made at stitch lengths as long as 2.5 to 3 mm.

Recommended stitching yarn counts for the individual sliding needle gauges used in the forming of apparel fabrics.

Coarse needle: from 100 tex to 50 tex (Nm 10 to Nm 20)
Medium needle: from 50 tex to 25 tex (Nm 20 to Nm 40)
Fine needle: from 34 tex to 10 tex (Nm 30 to Nm 100)
Very fine needle: from 17 tex to 6.7 tex (Nm 60 to Nm 150).

When the very fine sliding needle (gauge 22 F) is used, it is advisable that the stitching yarn comes in the form of regenerated, or man-made, continuous filament yarn.

Fancy yarns, particularly when with a knopped or looped structure, can be used in the warp and weft yarn systems only. An exception are the textured filament yarns. These can be used with good results in all of the three yarn systems in the forming of apparel fabrics. Untwisted continuous filament yarns are very suitable for the stitching yarn.

- Elastic fabric
  Fully elastic stitch-bonded fabrics can be formed with two yarn systems, the stitching yarn and the weft yarn systems. The fabric has a specific appearance.
- Fabric weight per unit area
  In apparel fabrics, the fabric weights per unit area achieved so far range from 80 g/m² to 450 g/m².
  The following tendency can be stated:
  Gauge 22 F – 80 g/m² to 220 g/m²
  Gauge 18 F – 120 g/m² to 300 g/m²
  Gauge 14 F – 180 g/m² to 380 g/m²
  Gauge 10 F – 280 g/m² to 450 g/m²
- Warp alternating motion
  The warp alternating motion is particularly well suitable for the forming of apparel fabrics and drapery materials. The basic setting is the same as in apparel fabrics and drapery materials without racked pattern. The patterning warps are stitched on to the weft yarn layers. Patterning warps within the range between 125 tex and 25 tex (Nm 8 and Nm 40) should be preferred to avoid additional tensions in the stitching yarn due to the knitting-in of the patterning warps, and to obtain a patterning effect.

1.4. Industrial textiles

The bulk of the output of sewing-knitting machines type Malimo is in the line of industrial textiles. Here, a high increase in the application of machines type Malimo is expected to take place at home and abroad in the course of the next few years.

Owing to the specific position of the warp and weft yarns in the Malimo stitch-bonded fabric and to its special structure, these fabrics are excellently suitable for subsequent processing, such as coating, and ensure a high service value of the final product. Malimo fabrics are used as industrial textiles in the applications compiled in Tables 1 and 5. The yarns worked up into industrial textiles are mainly high-tenacity viscose, polyamide, and polyester continuous filament yarns (hard twisted) for high-strength lining, interlining, and covering materials. In most cases a comparatively fine stitching yarn (polyamide or polyester continuous filament yarn) will suffice to bond the coarse warp and weft yarn layers and to hold together the structure as a sufficiently stable stitch-bonded fabric until coating or other subsequent processing is carried out. The advantage that a very small amount of stitching yarn is required will be particularly appreciated in the fibre glass and asbestos fibre products to be made on Malimo machines. Heavy insulation mats are formed with comparatively fine stiching yarn of fibre glass or polyester continuous filament yarn (30 tex or 10 tex, i. e. Nm 33 or Nm 100) which bonds the coarse warp and weft yarns positioned at high density (some 40 to 250 ends per decimetre; 200 tex to 1600 tex). When coarse yarn are positioned at high warp density it is advisable to use a separate warp guide bar with

Table 4

Article	Yarn count in tex (Nm)			Machine gauge mm	Stitch length mm	Fabric weight per unit area g/m²
	Stitching yarn	Warp yarn	Weft yarn			
Blouse material	7 6 (132) PE-S	--	15 (67) PE-S-t	22 F	0 5	100
Dress material	18 (56) × 2 VI-F/Wo	–	56 (18) VI-F/Wo	18 F	1.3	220
Suiting	10 (100) PE-S	24 (41) × 2 Wo/PE-F	24 (41) × 2 Wo/PE-F	22 F	0 7	200
Beach wear	25 (40) Bw	170 (5 8) fancy yarn	36 (28) Bw	14 F	1.7	270
Bath wear fully elastic	10 (100) PA-S-t	-	10 (100) PA-S-t	18 F	0 9	220
Children's trouserings	17 (59) PA-S-t	17 (59) PA-S-t	24 (41) VI-F/Wo	18 F	1.0	360
Jacket material	83 (12) Wo/VI-F	-	–	10 F	2 6	420

Table 5

Article	Yarn count in tex (Nm)			Machine gauge	Stitch length mm	Fabric weight per unit area g/m²
unit apea	Stitching yarn	Warp yarn	Weft yarn			
Ply in conveyor belt	76 (13) PA-S-kt	92 (10.8) PA-S-kt	190 (5,3) PA-S-kt	7 F	2 5	760
Tarpaulin	30 (33) PA-S-kt	77 (12.5) PA-S-kt	77 (12.5) PA-S-kt	18 F	1 4	265
Back for imitation leather	17 (59) VI-S		20 (50) VI-F	22 F	1 1	115
Back for floor coverings	22 (45) VI-S	125 (8) mixed shoddy	125 (8) mixed shoddy	12 F	2 0	230
Bags	64 (16) VI F		polyethylene slit films	3 F	2 4	125

special yarn feeding device, and in certain cases these may even become indispensable.

Other materials to be worked up particularly into industrial textiles are polypropylene or polyethylene slit films which can be used equally well in any of the three yarn systems.

Working up of cotton yarns and bast fibre yarns, viscose filament yarns, and mixed shoddy yarn into special fabrics is usual practice. The principle underlying the working-up of these yarns on sewing-knitting machines type Malimo is the same as quoted for any of the yarns discussed so far.

Some special advantages of such stitch-bonded industrial textiles are stated in the following.

- Interlining material subjected to tension:

Strength values up to 300 kgf/cm in longitudinal direction and up to 150 kgf/cm in crosswise direction at optimum resilience; high absorption of work; little permanent strain; suitable for endless belts; high productivity both in manufacturing the insert and the conveyor belt; little expenditure of material.

- Covers and protective inserts for conveyor belts:

For the manufacture of 100 m^2 of conveyor belting, covered on one side, 252 m^2 of woven fabric are used up for the protective plies, while in the same application only 100 m^2 of stitch-bonded fabric are consumed. When stitch-bonded inserts are used, expenditure of labour is reduced to 14 per cent as compared to woven inserts.

- Filter cloth

If a stitch-bonded filter cloth made of PVC spun yarn and having a fabric weight per unit area of 550 g/m^2 is used, the output in filtration is increased by 20 to 25 per cent as compared to the output obtained with a woven filter cloth made of PVC spun yarn and having a weight per unit area of 540 g/m^2. The filtering action, too, is improved by some 20 per cent as compared to that of a woven fabric.

Advantages offered in general by all stitch-bonded industrial textiles:

1 high tear resistance
2 little elongation and little extension in crosswise direction
3 adhesive power to coating materials improved to 210 per cent as compared to similar woven fabrics, and that even without auxiliaries
4 the average efficiency of one manpower-hour is in the range of 120 to 230 m^2 as compared to 90-170 m^2 of woven fabric.

A large field of application is in the production of backing material for imitation leather. A wide variety of backing fabrics formed on 10-gauge through 22-gauge machines and made with two or three yarn systems of various fibres (mixed shoddy viscose, cotton) is produced and used for a wide range of imitation leather grades.

In the next few years, the use of sewing-knitting machines type Malimo is expected to increase considerably owing to the development of other industrial textiles for the building industry, agriculture, vehicle construction, and many other branches of industry

2. Possibilities of patterning

Patterning in Malimo fabric forming is determined by the structure and the intermeshing of the stitch-bonded fabric undergoing forming, and by the variations imparted by the machine. Subsequent patterning in finishing (dyeing, printing, embossing, etc.) is the same for both Malimo stitch-bonded fabrics and conventionally woven or knitted fabrics.

2.1. Patterning according to fabric structure and intermeshing

2.1.1. Single-colour and multiple-colour designs

Single-colour patterning can be achieved by using uni-coloured yarns different in fibre compositions or yarn counts. Yarns different in colours which are threaded into the warp feeding device or the weft carrier according to the pattern yield interesting multiple-colour effects in the stitch-bonded fabric.

For patterning with warp stripes the stitching yarn must match the colour of the warps. If plain chain stitch is used, longitudinal stripes can be achieved with the aid of coloured stitching yarns.

Structure resembling a knitting fabric in apperance and a woven fabric in properties are formed by interlocking chain stitch without warps. The stitching yarns are comparatively coarse.

If yarns with different properties are used, such as shrinkable, textured yarns, fancy yarns and twisted yarns with a knopped or looped structure, bi-component yarns, etc., patterns are produced which are both unique and typical of the Malimo method of intermeshing.

In most cases, patterning by different yarns in the stitching, weft, and warp yarn systems is applied. Patterning with one yarn system only, or with two systems matching in colours, is possible. The pattern designer must exactly know the position of the individual ends within the stitch-bonded structure in order that he may design patterns with the optimum optical and aesthetic appearance. Special attention should be paid to the geometric arrangement of the weft yarns in the fabric. Some theoretical aspects with regard to it are covered by (6).

Different coloured threading produces jaspe-type patterning, and in case of coloured groups of yarns within the sheet of weft yarns coloured, overlapping rhomboids are obtained which again can feature a jaspe-type pattern. In a single sheet of weft yarns composed of different coloured groups of yarns the patterning of the face re-occurs as a mirror-inverted pattern on the back of the cloth.

If the weft carriage is threaded half with patterning yarns and half with uni-coloured yarns when two sheets of weft yarns are used, the stitch-bonded fabric produced is unicoloured on one side and patterned on the other side. Such weft yarn patterning can be applied where fabrics with a well-closed surface are formed.

2.1.2. Back-patterned fabric

The patterning is produced by introducing a different coloured backing fabric underneath the weft yarns. The set of the weft yarns must be comparatively open according to the pattern. For the backing fabric fibre webs, woven fabrics, knitted fabrics, stitch-bonded fabrics, and foamed plastics can be used. In dependence upon the open set of yarns, the distribution of the weft yarns, and the angle of intersection of the weft yarns positioned various mottled effects can be obtained without mottled yarn. The best effect of a plastic pattern is obtained when fibre webs without any, or with little, preliminary compression are used. Applications are wall covering materials. Stitch-bonded Maliwatt fabrics produced on coarse-gauge machines or adhesive-bonded nonwovens are used for the backing fabric.

Back-patterned fabrics can also be produced by laminating. Stitch-bonded Malimo fabrics with an open set are suitable for the overlay, while fine, light-weight, unicoloured war-knitted fabrics are suitable for the back. Besides these possibilities of patterning which are partly typical of Malimo an attachment has been developed to extend the patterning possibilities of Malimo stitch-bonded fabrics.

2.2. Patterning device for Malimo sewing-knitting machines type
Malimo Warp racking attachment

The development of this attachment could be realized to resemble the principle underlying warp knitting, without adding intricacy to the stitching area of the sewing-knitting machines type Malimo. Patterning warps are displaced through laterally racked patterning warp guides.

The bars are controlled from a patterning mechanism to operate in the parallel or counter-laying mode. The patterning mechanism can be equipped with pattern disks or with pattern chains. The maximum lateral displacement is 120 mm, and the maximum height of repeat is 180 courses at disk control, while at chain control the height of repeat depends upon the pattern chain. The patterning warps added can be laid in the form of a sinusoid, or alternately in the form of a sinusoid and a straight line with one guide bar each, according to the pattern and the pattern control. The bonding of the patterning warps can be performed by intermeshing the stitching yarn at interlocking chain stitch or, conditionally, at plain chain stitch. The warp racking attachment does not materially reduce the output of sewing-knitting machines type Malimo.

2.3. Patterning in finishing

Under this heading, one finishing method only will be mentioned which has been widely used in the last few years: the burn-out process. Burnt-out effects are achieved by the cauterization of certain fibre components in textile fabrics which are composed of mixture yarns, and the dyeing of the remaining fibre portions at a time. Owing to their structure and the method of intermeshing, stitch-bonded Malimo fabrics are particularly suitable for fabrics that can be subjected to finishing according to the burn-out process.

3. Determination of specific quantities

When new stitch-bonded products are being designed, certain requirements with regard to fabric weight per unit area and strength must be met. Therefore, the technologist must be capable of constructing and calculating the fabric in accordance with the requirements in advance.

Three yarn systems and two kinds of intermeshing are available for the construction of a stitch-bonded Malimo fabric. The following combinations can be applied:

a) Weft yarn system and stitching yarn system intermeshed by plain chain stitch (Fig. 1),
b) Weft yarn system and stitching yarn system intermeshed by interlocking chain stitch (Fig. 2),
c) Weft yarn system and warp yarn system and stitching yarn system intermeshed by interlocking chain stitch (Fig.3)

Since the weft and warp yarns lie nearly stretched in the fabric it is easy to determine the required quantity of these yarns. The stitching yarns are formed into loops. The take-up of these yarns depends upon several factors which will be explained in the following.

3.1. Stitching yarn take-up

Stitching yarn take-up, E, is determined in per cent as follows:

$$E = \frac{l_F - l_W}{l_F} \cdot 100$$

where

l_W length of stitch-bonded fabric in m

l_F length of yarn in the fabric, in m

In certain cases, the take-up ratio, e, is stated instead of the take-up. It is determined as follows:

$$e = \frac{l_W}{l_F}$$

Stitching yarn take-up is influenced by several factors such as stitch length, set of weft yarn, yarn counts of all three yarn systems, machine gauge, tension of stitching yarn.

Stitch length exercises the greatest influence on take-up, then follow count of stitching yarn and weigth of weft yarn. The rate of take-up in the stitch-bonding technology type Malimo ranges between 71 and 83 % at interlocking chain stitch, and between 71 and 78 % at plain chain stitch.

In a fabric having a weight of 220 g/m^2, changing the stitch length from 1.1 mm to 1.5 mm, for instance, can reduce take-up by 2 per cent, while changing over from 1.5 mm to 2.2 mm can reduce take-up by 3 per cent.

Owing to the many factors influencing take-up, a general view of take-up percentages on which yarn calculations could be based can hardly be given. Every stitch-bonded fabric must undergo measurement if the degree of take-up is to be established. Such measurements can be carried out in the following manner:

1. Marking of a certain yarn length and measuring the fabric length made of it
2. For large pieces, calculation of take-up from the warped lengths of the warp and stitching yarns and the fabric made of them
3. Application of yarn feed measuring devices.

The measuring device Kokett developed for warp knitting machines can also be used on Malimo machines provided that a special sleeve is installed. The device can be used on all Malimo machines working from beams.

Measurements are made with the machine being operated. The instrument measures the length of yarn worked up into a predetermined number of courses, and the length of the fabric made.

3.2. Calculation of the weight per unit area of the loom-state fabric

The weight per unit area of the loom-state fabric is calculated from the weight percentages of the individual yarn systems, i. e.

- for three-yarn systems, $m = m_N + m_K + m_S$
- for two-yarn systems, $m = m_N + m_S$

where

m weight per unit area of the loom-state fabric, in g/m^2
m_N weight of the stitching yarn, in g/m^2
m_K weight of the warp yarn, in g/m^2
m_S weight of the weft yarn, in g/m^2

The general formula for the determination of the weight percentage of one yarn system is

$$m = \frac{\text{Set of yarn}/m \times \text{Tt} \times \text{working width}}{(100-E) \times \text{width of the grey fabric} \times 10}$$

when take-up is applied,

or

$$m = \frac{\text{Set of yarn}/m \times \text{Tt} \times \text{working width}}{e \times 1000}$$

when the take-up ratio is applied,

where

Tt = yarn count in tex
working width in m
grey fabric in m – measured from one outermost stitching yarn to the other.

Unlike take-up of the stitching yarn (71 % to 83 %), take-up of the warps can be 0.8 % to 8 %, and that of the weft yarns 0.9 to 4.8 %. Take-up materially depends on machine gauge, stitch length, and set of the weft yarns.

3.3. Calculation of the yarn required in the production of the loom-state fabric

Calculations are made according to paragraph 3.2., with due consideration given to the losses in processing. The yarn required is calculated from the material required for the individual yarn systems, i. e.,

- for three yarn systems, $m_B = m_{NB} + m_{KB} + m_{SB}$
- for two yarn systems, $m_B = m_{NB} + m_{SB}$

where

m_{NB} material required for the stitching yarn, in g/m^2
m_B material required for the loom-state fabric, in g/m^2
m_{KB} material required for the warp yarn, in g/m^2
m_{SB} material required for the weft yarn, in g/m^2

The general formula for the calculation of the material required for one yarn system is

$$m_{FB} = m \times \frac{100}{100 - V}$$

where

m_{FB} material required for one yarn system, in g/m^2
V loss in yarn of one yarn system during processing, in %.

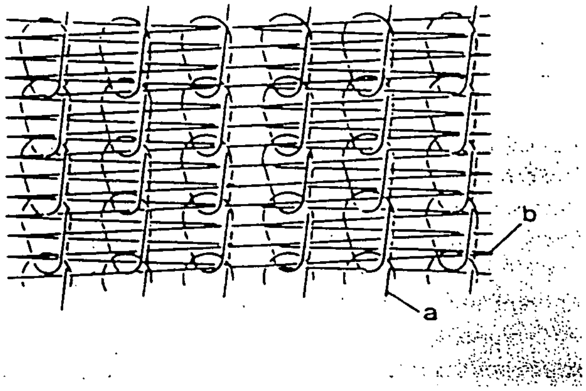


Fig. 1 Type of intermeshing : Plain chain stitch
a) Stitching yarn b) Weft yarn c) Warp yarn

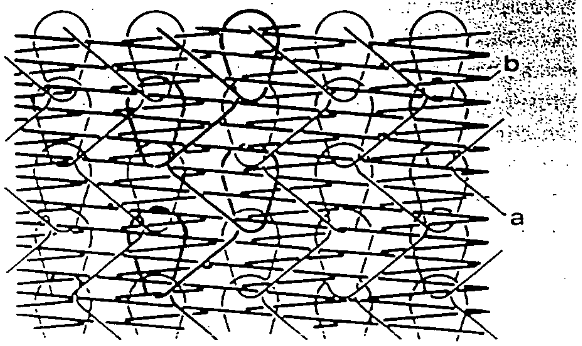


Fig. 2 Type of intermeshing: Interlocking chain stitch with two yarn systems
a) Stitching yarn b) Weft yarn

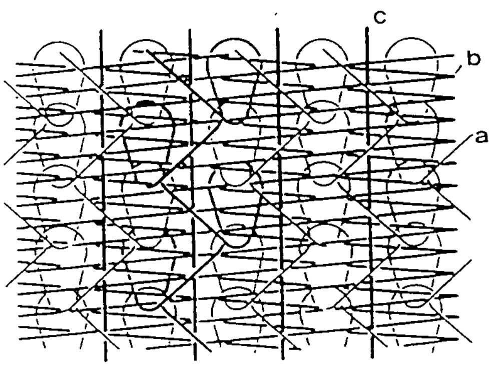


Fig. 3 Type of intermeshing: Interlocking chain stitch [illegible] yarn systems
a) Stitching yarn b) Weft yarn [illegible]

3.4. Determination of the strength of stitch-bonded fabrics type Malimo

3.4.1. Theoretical determination of strength

The strength requirements made on every product vary greatly. This point of view should be taken into consideration already in the construction and development stage of stitch-bonded fabrics where a new article is planned. This can be done, proceeding from the following considerations:

The strength of a stitch-bonded fabric depends upon the number of yarn systems used, the number of ends, and the strength of the individual yarn.

Strength in longitudinal direction: When all three yarn systems are used, strength is imparted to the stitch-bonded fabric by the warp ends. Tensile strength is obtained from the sum of the strengths of the individual warp ends, the number of warp ends based on that corresponding to the test width in the tensile test.

When large stitch lengths and high-tenacity stitching yarns are used, value actually determined is higher, because the stitching yarns add to the strength in longitudinal direction in tensile testing.

In Malimo stitch-bonded fabrics made of two yarn systems tensile strength is imparted by the stitching yarns. It is obtained from the sum of the strengths of the individual stitching yarns plus a percentage owing to stitch formation, that percentage amounting up to 5 % depending on the stitch length and the material of the stitching yarn.

Strength in crosswise direction: Strength in crosswise direction is obtained from the sum of the individual weft yarn strengths in dependence upon the set of the weft yarns and the test width specified for the strip tensile test. At small stitch lengths, high-tenacity stitching yarns, and coarse machine gauge the value determined in actual production will be somewhat higher, because the stitching yarn may add to strength.

3.4.2. Determination of strength in partice

Strength testing of stitch-bonded fabrics Malimo can be carried out with the aid of the strip tensile test, or with the bursting strength tester. For the usual strip test, strips 50 × 200 mm in size are taken from the stitch-bonded fabric in both directions and torn with the tensile tester. Testing in crosswise direction yields no real values, because the test samples cannot be cut on the weft grain owing to the biassed position of the weft yarns in the cloth.

Testing of the bursting strength seems to be more suitable for Malimo fabric strength determinations. To allow the strength in crosswise direction to be compared with that of woven fabrics the attempt was made to obtain real strength values of stitch-bonded fabrics by determining the number of ends in the stitch-bonded test strip that are subjected to tension

Considering a tensile test strip 50 × 200 mm in size, the strip contains a large number of cut weft yarns. The number of weft yarns tested depends on the angle of intersection of the weft yarns in the stitch-bonded fabric. It is, therefore, necessary to determine a number of weft yarns subjected to tension as in actual use and then to convert that number according to the size of the test strip. Example for the calculation of the number of weft yarns subjected to tension, n_S.

Size of test strip	50 × 200 mm
Set of weft yarn	72 ends/dm
Number of weft yarns per 50 mm width tested	36 ends
Half angle of intersection	$\alpha = 5°$
Strength determined by testing	55.5 kgf

$$n_S = \frac{\text{Set of weft yarn/dm [width tested} - \text{(length between clamps} \times \tan \alpha)]}{100}$$

$$n_S = \frac{72\,[50 - (200 \times 0.8749)]}{100} = 23.47$$

The ratio of weft ends/50 mm to the number of yarns subjected to tension gives the percentage of the ends that correspond to the strength value measured.

The actual test value of 55.5 kgf only corresponds to 63.3 % of the strength actually inherent in the stitch-bonded fabric.

Actual strength in crosswise (weft) direction of the stitch-bonded fabric

$$F_{\text{eff}} = \frac{\text{Test value}}{\text{\% of ends subjected to tension}} \times 100$$

$$F_{\text{eff}} = \frac{55.5 \text{ kgf} \times 100 \,\%}{63.3 \,\%} = 87.7 \text{ kgf}$$

As shown by example, the difference between the strength value measured in tensile testing and the actual strength value is remarkable. It should, therefore, be aimed at including into the standard of test the correction of actual strength values for stitch-bonded fabrics. This would enable a realistic comparison to be made between the strengths of woven and of stich-bonded fabrics at any time.

4. Faults in Malimo stitch-bonded fabrics

Faults and troubles arising in the manufacture of Malimo stitch-bonded fabrics may be due to the following causes:

1. Selection of the material, unsuited yarns, wrong grade of yarn
2. Yarn preparation
3. Manufacturing process of the stitch-bonded fabric

4.1. Faults due to inadequate yarn preparation

At times, yarn breakages whose causes can be traced back to yarn preparation occur in the stitch-bonding process. Inadequate yarn preparation includes insufficient elimination of thick and thin places in the yarn in cross winding, lowgrade weft bobbins, and unsuited knots. Care should be taken that the usual weaver's knot is applied.

Yarn breakage also occurs frequently when the yarn has been damaged by the yarn preparation process, for instance, by too high a yarn tension in warping.

4.2. Faults due to the stitch-bonding process

In the stitch-bonding process the following faults may occur. Yarn breakage in the stitching, warp, and weft yarn systems, dropped stitches, double stitches, faulty closing wire operation, faulty sliding needle operation, wrongly positioned weft yarns. Yarn breakage, it not due to low-grade yarn, can be due to too high a yarn tension, faulty yarn guiding elements and stitching elements, and double laying. Dropped stitches can be caused by wrong machine setting, faulty stitching elements, slack ends owing to too low a yarn tension or improperly warped beams, unsuited stitching yarn, and too high a warp tension.

Double stitches occur when the loop being formed on the sliding needle is not knocked over properly in forming the stitch but is knocked over only together with the loop formed next.

This can be attributed to wrong machine setting, or different yarn tensions.

Faulty closing wire operation is recognized by an unclean appearance of the stitches. The fault is caused by dirt accumulation or wrong setting of the stitching elements. Wrong laying of the weft yarns is caused by wrong weft tension, wrong machine setting, or electrostatic charging in synthetic yarns. The latter can be eliminated by using a point ionizer. Loose courses can be reduced to a minimum by an exact setting of the machine; however, they cannot be entirely excluded as is already known from warp knitting. The problem greatly depends on the material being worked up. Loose courses are influenced by the tension of the stitching yarn, the elasticity of the stitching yarn, and the working speed (starting and running down of the machine).

5. Finishing of Malimo stitch-bonded fabrics

It should be stressed that no special finishing plants are required for the finishing of stitch-bonded fabrics, nor have been developed. The finishing plants already existing are partly adapted to the processing of Malimo stitch-bonded fabrics. There are required but little alterations and additions. Worth mentioning are the continuous plants where stitch-bonding machines type Malimo are interlinked with a sizing attachment and a dryer, especially for the production of insulating gauze. These plants can be considered space-makers of future special plants combining in one line fabric forming and finishing plants.

Optimization of the finishing technology is necessary for the processing of Malimo stitch-bonded fabrics in dependence upon the character of the cloth which can resemble a woven or a knitted fabric. All chemical and physical processes as well as the addition and application of auxiliaries are to be optimized in accordance with the spun yarns and filament yarns used, and the end-use

Part 3
Technical possibilities and technology of the Malimo Sewing-knitting machine type Schusspol

0. Introduction

Malimo Sewing-knitting machines type[1] Schusspol are used for the production of single-sided pile fabrics. This machine type differs from Malimo sewing-knitting machines of the Malipol type in that the high-quality pile thread material constitutes to 100 % the face of the fabric and, at the same time, covers the backing of the fabric.
Type Schusspol was developed from type Malimo which, owing to its versatile applicability and high productivity has proved to be useful in many fields of light industry.

1. Definition and manufacture of the stitch-bonded fabric

1.1. Definition

The term „Schusspol" is derived from the movement of the operating element that laps the pile thread. Pile thread lapping takes place like the weft lapping known in warp-knitting, i. e. the thread is lapped on the underside (back) of the sliding needles (knitting needles) over several needle spacings. Stricly spoken, the operation in question is a weft lapping under two needles over a pile forming element (pile sinker) which forms the thread in each course into a pile loop.

1.2. Thread systems

The stitch-bonded fabric is formed from three thread systems in a single operation. The prefabrication of a backing cloth as required for other techniques such as tufting or Malipol can be omitted here. A sheet of weft yarns is fed to the stitch forming area by means of the weft laying carriage and the weft yarn conveying mechanism similar to that of type Malimo. The weft yarns are stitch-bonded with the stitching yarn. The two thread systems form the backing of the pile fabric. At the same time, the sewing-knitting process bonds the pile threads to the stitching yarn stitches to form a stitch-bonded fabric as shown diagrammatically in Fig. 1.

1.3. Manufacturing the stitch-bonded fabric
1.3.1. Lapping

The lapping of the pile thread has already been referred to as weft lapping under two needles. The stitching thread is a lapped at plain chain stitch. The movements of the stitching yarn guide bar and of the pile yarn guide bar are opposed to each other. As a result, a large angle of intersection is formed between the stitching and pile threads when the stitching thread is introduced into the hook of the sliding needle. The capillary fibres of the pile thread are prevented from being caught by the sliding needle. The bonding of the pile threads by the stitching threads must be firm. The height of pile loops is determined by the size (height) of the pile sinker depending

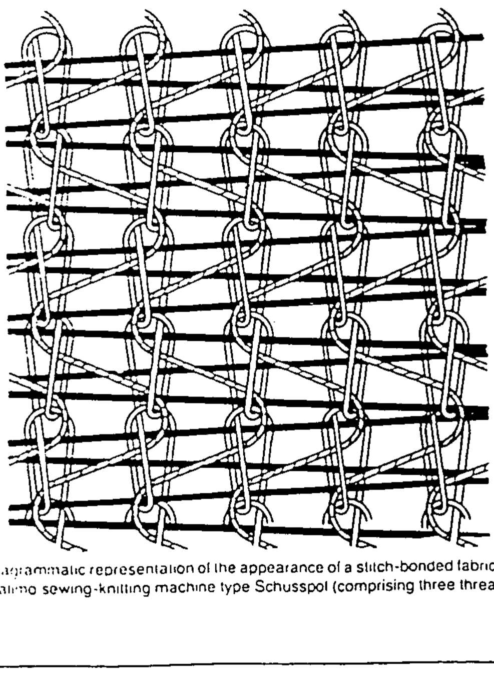


Fig. 1 Diagrammatic representation of the appearance of a stitch-bonded fabric made on a Malimo sewing-knitting machine type Schusspol (comprising three thread systems)

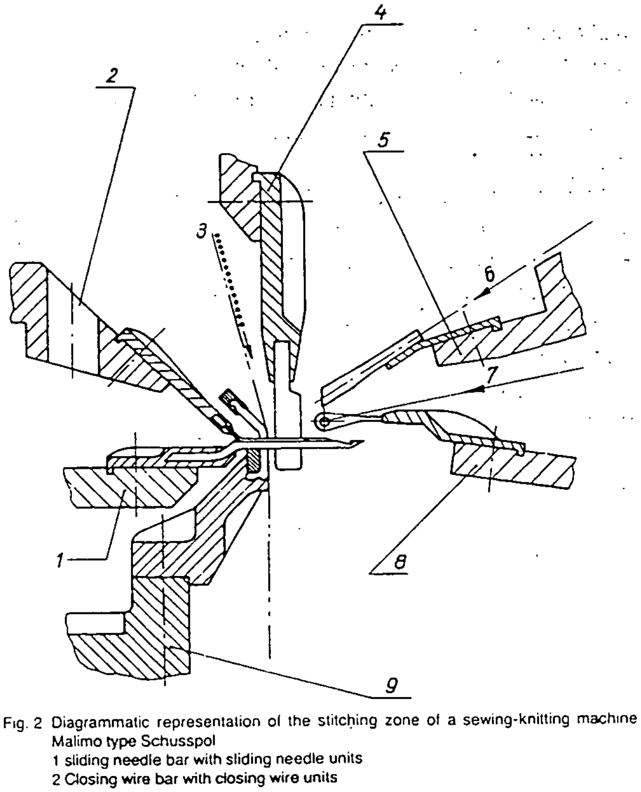


Fig. 2 Diagrammatic representation of the stitching zone of a sewing-knitting machine Malimo type Schusspol
1 sliding needle bar with sliding needle units
2 Closing wire bar with closing wire units
3 Weft yarn system
4 Pile sinker bar with pile sinker units
5 2nd guide bar with tubular yarn guide units
6 Pile yarn system
7 stitching yarn system
8 1st guide bar with guide needle units
9 Knocking-over sinker bar with sinker units

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[1] [illegible] is a registered trademark of the G D R Trademark Association for Sewing-knitting Machines and Stitch-bonded Fabrics Hohenstein-Ernstthal

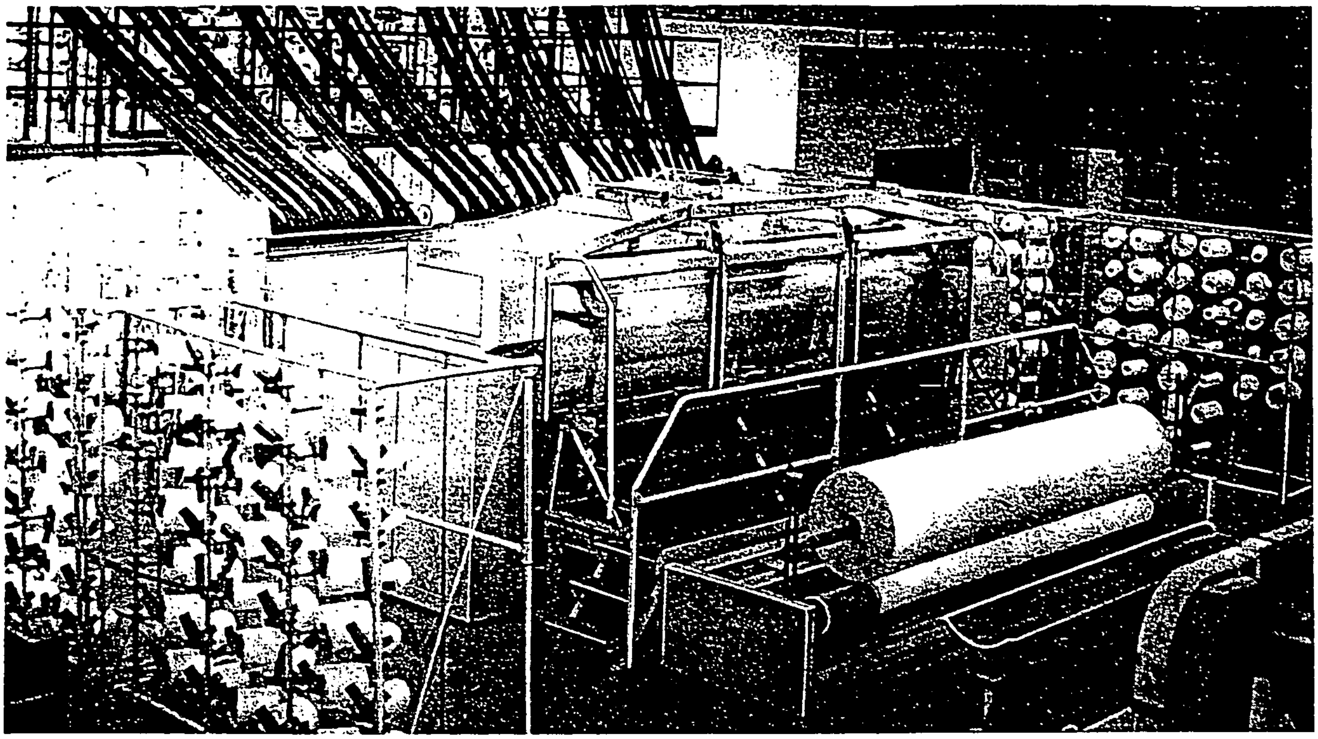


Fig. 3 Malimo sewing-knitting machine type Schusspol N-3600, model 14011, designed with beam stand for the stitching yarn for the production of wall-to-wall floor covering material multiple height tubular guide bobbin creels for the pile yarn; and coarse yarn bobbin creels for the weft yarn.

on the type and properties of the pile material, and the tension of the stitching and pile threads when being worked up. Both the 1st guide bar lapping the stitching thread (lower guide bar) and the 2nd guide bar lapping the pile thread (upper guide bar) return to their initial positions after every two lappings. Therefore, the gearing for the shog of the guide bars runs at half the main shaft speed of the machine. The sideways shog of the guide bars is effected by means of adjustable excentric cams or cam disks.

1.3.2. Stitch forming area and loop formation

Fig. 2 shows the sewing-knitting point of a Malimo sewing-knitting machine of the Schusspol type.

For a better insight into the process the motions of the stitch-bonding elements in forming the loops are described in a simplified way as follows:

1. The sliding needle bar moves to the front, the halfstitches previously formed are cast on.
2. Sideways shog of the pile thread guide bar under two sliding needles (weft)
3. Swing movement of the pile yarn and stitching yarn guide bars upwards through the spacings between the sliding needles.
4. Sideways shog of the stitching yarn guide bar over one sliding needle (plain chain stitch).
5. Closing wire bar moves forward, sliding needle hooks close
6. The sliding needle and closing wire bars retract together
7. Swing movement of the pile yarn and stitching yarn guide bars downwards through the spacings between the sliding needles
8. Knocking-over of the course cast on before.

2. Technical possibilities of the Malimo sewing-knitting machine type Schusspol

2.1. General

Malimo sewing-knitting machines type Schusspol are manufactured as model 14010 in nominal widths N-1600 or N-2400. The experience gained with the machine types of the model 14010 was applied to the model 14011 for larger working widths within the framework of a new design.

The model 14011 is characterized by a high operational comfort. The robust design permits a high degree of utilization in the working process.

To improve the running properties of the pile material the machines of the models 14010 and 14011 were equipped

2.2. Technical data

Table 1 Technical data of Malimo sewing-knitting machines type Schusspol

	Model 14011 N-3600	Model 14010 N-2400	N-1600
Nominal width in mm	3600	2400	1600
Working width in mm	2450-3600	1650-2425	1050-1625
Speed range, infinitely variable, r p m	350-830	250-700	250-750
Speed range in practice, r p m	350-600	250-550	250-550
Creep speed, r p m	about 30	17-47	17-50
Machine gauge F	5 7	5 7 10	5, 7 10
range of stitch lengths (theoretical) in mm	0 55-5 0 (24 steps)	0 7-5 0 (21 steps)	0 7-5 0 (21 steps)
Range of stitch lengths (practical for wall-to-wall carpeting)	2 0-3 5	2 0-3 5	2 0-3 5
Net weight with beam stand (kg)	11050	7440	5420
Yarn feeding · (stitching and pile threads)	infinitely variable	infinitely variable	infinitely variable
Pile sinker height in mm theoretical	1 2 3 4 5 7 9	1 2 3 4 5 7 9	1 2 3 4 5 7 9
practical (for wall-to-wall carpeting)	5 7	5 7	5 7
Connected load in KW	15	[illegible]	4 5

with tubular guide bobbin creels of flat design or in multiple heights. These creels have been introduced into series production along with the model 14011 machine.

Individual thread guidance in tubes ensures very favourable conditions for the feeding of the pile threads to the machine.

Fig. 3 shows a Malimo sewing-knitting maschine type Schusspol N-3600, model 14011, equipped with multiple-height tubular guide bobbin creels for the pile yarn, coarse yarn bobbin creels for the weft yarn, and beam winding-off stand for the stitching yarn for the manufacture of wall-to-wall carpeting.

2.3. Output of the Malimo sewing-knitting machine type Schusspol

The output of the machine depends on the speed of the machine, the stitch lengths, the working width, and the efficiency.

The output can be calculated according to the following equation:

$$N = \frac{60n \cdot L_{ST} \cdot b \cdot \eta \cdot 10^{-2}}{10^3 \cdot 10^3} \qquad (1)$$

$$N = \frac{6 \cdot nL_{St} \cdot b \cdot \eta}{10^7}$$

where

n speed in r. p. m.

L_{St} stitch length in mm

b working width in mm

η efficiency in %

N output in sq. m./hour

In practice, the sewing-knitting machine is operated at speeds between 500 and 600 r. p. m. for the manufacture of wall-to-wall floor covering material. Depending on the climatic conditions, quality of material used, preparatory operations (beaming warping), and the standard of the operative staff an efficiency of 40 to 65 per cent can be optained. The calculation of the output of a Malimo sewing-knitting machine type Schusspol model 14011 is illustrated by the following example:

$n = 600$ r. p. m.; $L_{St} = 2.5$ mm; $b = 3600$ mm; $\eta = 50$ %.

The figures given refer to the manufacture of wall-to-wall floor covering material, gauge 7, pile sinker height 7 mm

$$N = \frac{6 \cdot 6 \cdot 10^2 \cdot 2.5 \cdot 3.6 \cdot 10^3 \cdot 50}{10^7} = 162\ m^2/h$$

The example shows that the manufacture of floor covering material on this type of machine is highly productive

3. Textile-technological possibilities of the Malimo sewing-knitting machine type Schusspol

3.1. Applications

The Malimo sewing-knitting machines type Schusspol are preferably used to produce high-quality floor covering materials of synthetic pile materials. The fact that the pile material constitutes to one hundred per cent the cover of the fabric makes the application of this type of machine interesting. With the materials used economically, the pile material can be fully utilized and a good covering of the stitch-bonded backing attained.

Typical features of this type of stitch-bonded fabrics are: highly attractive in appearance, very uniform pile, high resistance to static and dynamic compressive stresses, rapid recovery of the pile loops after static compressive stress, specific structure of the pile, low sensitiveness to soiling, and ease of care.

To ensure for the properties mentioned to take effect it is necessary that the grey fabric made on the sewing-knitting machine is finished accordingly.

Especially with regard to synthetic pile material the firm chemical bonding of the individual capillary fibres of the pile loops to the stitch-bonded backing is essential in order to avoid pilling. Subsequently, the coating proper of the fabric back is effected to impart the carpeting additional properties such as an anti-slip backing, resistance to cutting dimensional stability, sound and heat insulation, and an increase in resilience.

3.2. Textile-technological particulars

Good running properties of the thread system are achieved at a temperature of 23 ± 3°C and a relative humidity of 60 to 70 per cent. Special attention should be paid to an appropriate feeding of the yarn. As a general rule, the yarn supplied should have large slub-free lengths and, provided that a sufficient breaking strength is warranted, minor irregularities as well. When choosing the yarn and the types of packaging to following aspects should be taken into account:

Weft yarn: The relatively coarse threads should produce little fly (fluff) when processed. Large slubs will clog the weft carrier and cause trouble to the stitch forming area. The weft yarn is only little stressed.

Stitching yarn: For the highly stressed stitching yarn, man-made high-tenacity, low-elongation continuous filament yarn should only be used. High quality of warping and beaming should be sought to ensure a trouble-free running of the machine.

Pile yarn: The yarn determines character of the face and, hence, the main quality features of the fabric. High demands should be made on yarn count and dyeing, the latter being important to avoid streakiness. When using synthetic materials it should be noted that owing to the resilience of the yarn the actual height of the pile will differ from that provided for by the pile sinkers. Low pile thread tensions should be aimed at because the stitching yarn tension must also be increased as the pile yarn tension rises. Textured polyamide filament yarn is well suited for the pile threads. When employing spun yarn the surface of the yarn should be compact and the percentage of shortstable fibres low.

The materials recommended for the manufacture of wall-to-wall floor covering material on 5 and 7-gauge machines type Schusspol are specified in detail in Table 3.

Table 3

Thread system	Material	Gauge
Stitching thread	Polyamide cord yarn	76 94 tex
Pile thread	Polyamide continuous filament yarn, textured	250 334 tex
	twisted and untwisted Viscose carded yarn	200 tex × 2
Weft thread	Viscose coarse yarn	200 300 tex
	(jute type) Vigogne yarn	250 350 tex

These materials yield grey fabric weights (not including back coatings) ranging from 800 to [illegible]

3.3. Pile loop density

It is especially for textile floor covering materials that the structure and the quality of the pile loops that cover the backing is decisive for the utility value of the carpet. The covering of the backing depends upon the number of pile loops per unit area, pile height, and specific properties of the pile material used. The number of pile loops per unit area is determined by the machine gauge in transverse direction and by the stitch length in longitudinal direction.

The number of pile loops, n_P, in an area of 100 mm × 100 mm is calculated as follows:

$$n_P = 4 \cdot F \frac{100}{L_{St}} \qquad n_P = \frac{400\,F}{L_{St}} \qquad (2)$$

where

n_P number of pile loops in 1/sq.dm

F machine gauge (needles per 25 mm)

L_{St} stitch length in mm

Certain relations exist between the machine gauge, materials used, stitch lengths, and pile heights depending upon the article to be manufactured. In practice, a highly durable floor covering material with 1,120 pile loops/sq. dm (7 F), or 667 pile loops/sq. dm (5 F) is manufactured using the following parameters: stitch length 2.5 mm, gauge 7, or stitch length 3 mm and gauge 5, pile height 7 mm each, the pile material being textured polyamide filament yarn.

3.4. Possibilities of patterning

Patterning is possible by threading multicoloured pile threads, or threading the pile threads according to the pattern, and by using mouline twist. Schusspol stitch-bonded fabric is well suited for printing because of the high uniformity of the pile. The pile yarn used in the stitch-bonding process is natural white synthetic filament yarn.

4. Technical and textile technological improvements

Technical improvements tend towards wider fields of application, steady increase in output, and better working conditions and operational comfort of machines. In the field of textile technology, there are great possibilities of applying Malimo sewing-knitting machines type Schusspol. By extending machine gauges to 10 F new aspects emerge for the application of this machine. For instance, the production of upholstery and furnishing fabrics could become significant.

Application of Malimo sewing-knitting machine type Schusspol for the production of textile floor covering material

0. Introduction

The demand for textile floor covering material has rapidly grown in the past few years and is expected to go on rising also in future. This need can solely be met by using novel, highly efficient techniques. As for composite fabric structures, the tufting and the raschel techniques have found a market. While the raschel technique is limited to some special articles only, the tufting technique predominates clearly.

The Malimo sewing-knitting technique type Schusspol is due to become an alternative to the tufting technique in the field of composite fabric structures in the future.

Development aims at providing a highly efficient method of manufacturing textile floor coverings without using a prefabricated base fabric (jute base fabric or synthetic bonded fabric). Thus, the Malimo sewing-knitting technique type Schusspol is, above all, an alternative that must be considered within the entire framework of national economy, particulary meeting the needs of users who are well-experienced in the field of filament forming. As all novel techniques do, the Schusspol-type Malimo sewing-knitting technique, too, makes it a condition that high-efficiency finishing and after-treatment lines, especially for back coating, follow the process of nonwoven fabric formation to obtain goods having both a high utility value and an attractive appearance. The Schusspol-type Malimo sewing-knitting machine and the novel Schusspol floor covering material were developed as a result of the close, socialist co-operation between

VEB Nähwirkmachinenbau Malimo, Karl-Marx-Stadt, and VEB Halbmond-Teppiche, Oelsnitz.

1. Nonwoven fabric formation

1.1. General

The stitch-bonded fabric is formed of three thread systems in a single operation warp, i. e. thread, stitching thread, and pile thread system (Table 1). Accordingly, the stitch-forming area of the Schusspol machine includes pile sinkers, sliding needles, closing wires, knocking-over sinkers, stitching yarn guides, and pile tube guides.

1.2. Beaming

Stitching yarn supply is off beams. The quality of beaming is of great importance to the efficiency of the sewing-knitting machine and the frequency of faults occuring in the fabric formed.

Experience has been gained with the direct beaming unit BUB 800. The threads are directly wound from the bobbin creel on to the beam. The most important demands made on the beaming unit are:

1. Constant winding speed across the entire winding diameter of the beam, and
2. constant thread tension across the whole width of the beam and its full diameter range.

These demands are met by speed regulation in dependence on the beam diameter and with the help of a couple of drawing rollers followed by a tension control roller. A traversing expansion comb is arranged in front of the couple of rollers. Other necessary accessories to the beaming unit include ionization device, pressing device, beam lifter, infinitely variable speed regulation within specified ranges, and infinitely variable tension control. The bobbin creel can be arranged for any type of bobbins, e. g. biconical stretched-filament bobbins to process polyamide cord with yarn counts ranging between 76 and 94 tex. The beamer is suitable to receive Malimo beams N 1000 of the screwed type having the dimensions shown in Table 2.

1.3. Sewing-knitting

The description and technical data of the machine can be obtained from 2.2. The three thread systems are available in the following form:

Weft	conical or cylindrical crosswound bobbins
Stitching yarn	beamed
Pile yarn	conical or cylindrical crosswound bobbins

The yarn feeding units for the sewing-knitting machine were chosen in accordance with the kind of packaging or winding-up. The weft cheeses are creeled to two bobbin creels arranged laterally of the sewing-knitting machine. Three stitching yarn beams can be placed into the beam winding-off stand. The pile yarn bobbins are creeled to creels arranged behind the sewing-knitting machine.

Table 1

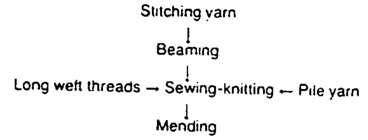


Table 2

Winding-up tension in kgf		from 0 to 110
Winding-up speed in m/min		from 0 to 300
Efficiency in %		from 50 to 55
Connected load		220/380 V/50 c p.s
Capacity in KW		13
Compressed air requirement	in kgf/sq cm	8
	in litres/min	30
Dimensions in mm	Total length	20.165
	Maximum width	3.790
	Maximum height	2.050
Space requirement in sq m (not including areas for handling and storage)		77
Operating weight in kg		some 4.200
Maximum distance between flanges in mm		1.200
Maximum diameter of flanges in mm		800
Diameter of steel tube in mm		152
Total length over journals in mm		1.800

Table 3

Compressed air requirement in kgf/sq cm		6
Creel dimensions,		
Flat creel in mm	length	11 780
	width	8 020
	height	2 340
Creel in multiple heights in mm	Space requirement in sq mm	94 5
	Length	5 540
(not including the operating platform and yarn storage area)	Width	8 020
	Height	4 800
	Space reqirement in sq m	44 5
Dimensions of the sewing knitting machine in mm with flat creel	Length	19 330
	Maximum width	9.725
	Space requirement in sq m (not including areas for handling storage)	188
with creel in multiple heights	Length	14.280
	Maximum width	9 725
	Space requirement in sq m (not including storage and handling areas)	139

The creel for the pile bobbins (Table 3) is erected of individual segments mainly consisting of angular steel. Feeding the pile threads individually in polyethylene tubes from the creel to the sewing-knitting machine has proved to be particularly advantageous.

The bobbin creels with tubular yarn guides for magazine creeling of conical or cylindrical cross-wound bobbins are made as flat creels or as creels in multiple heights. The centre distances of the creeling points related double-ended bobbin holder arms are 610 mm in horizontal direction and 260 mm in vertical direction. One segment of the creel has 126 mm creeling points. A creel comprises 8 creel segments having a total of 1,008 creeling points and a total of 2,016 skewers (magazine creeling).

Pile yarn tension is controlled by infinitely variable thread tensioners (wrapping-type yarn brakes). The thread tensioners are arranged on the tube ends facing the creel. The threading of the pile yarn into the little tubes is easily effected with the help of a compressed-air gun. Flat creels feature four creel segments each arranged in a rank and two segments each arranged one after the other. The walk ways should be at least 700 mm wide. Bobbin creels in multiple heights with tubular yarn guides have four creel segments at each height, a side-staircase, and a platform for yarn storage at the top stage. The admissible loading of the platform is 250 kgf/sq.m. Tubes are laid in bundles to the beam winding-off stand. Numbered plates on the beam winding-off stand facilitate trouble-shooting in the creel. The pile fabric produced is wound up by a rising roll batcher in the rear of the sewing-knitting machine.

1.4. Textile-technological experience

Optimum running properties are achieved at a temperature of 23 ± 3 °C and relative humidity of 65 ± 5 %. The materials to be used can differ widely, depending primarily on the final article desired. On the other hand, the material chosen greatly determines the output capacity of the machine. Hence, the user will have to find out by himself the optimum of quality and quantity.

The materials mentioned can be processed on 5 F and 7 F-gauge machines. In terms of the stitch-bonded fabric, this corresponds to some 20 pile threads/dm for 5 F and about some 28 pile threads/dm for 7 F. Stitch length adjustment is highly variable. Accordingly, the appearance of the final articles (set of the pile) and, decisively the output (metres of fabric produced by the sewing-knitting machine) may differ. For instance, if textured polyamide filament yarn is used for the pile material and 2,5 mm stitch length in a 7 F-gauge machine, or 3 mm in a 5 F-gauge machine, a highly durable fabric having some 1,120 pile tufts per sq.dm (7 F), or some 660 per sq.dm at 5 F, can be produced.

Particularly good results were obtained using pile sinkers 7 mm in height. It should be noted for the application of textured polyamide filament yarn that owing to the elasticity of the yarn the pile height over the backing is as low as 3 to 3.5 mm in the finished product. The weights to be obtaine.. of the grey fabric range between 700 and 1,300 g/sq.m. (not including back finish).

With the materials mentioned the sewing-knitting machine can be operated at speeds between 500 and 600 r.p.m., the efficiency ranging between 40 and 60 % depending on the quality of the material used and the standard of the operative staff. A sewing-knitting plant (i. e. inclusive of the creel) may be attended to by two persons complementing each other in a useful way.

1.5. Economical aspects

As in all the other textile fabic forming techniques the machine output largely depends on the set of the fabric. Therefore, it is always difficult to make an economical comparison and the values given below are very approximate ones.

The output of a sewing-knitting machine is 25 to 30 times the output of a boucle weaving loom. As compared with a raschel machine, the output of a sewing-knitting machine increases to 1.5 times or twice that of the former.

There is still another possibility of comparison. If the expenditure of operating time for 1,000 sq.m. of the finished article is considered to be 100 per cent for the sewing-knitting technique, the expenditure of work-time for other techniques are as follows: 400 to 600 per cent for boucle weaving, and 225 to 300 per cent for the raschel knitting technique.

1.6. Utility value

The utility value of a textile floor covering material depends not only on the fabric forming process, the materials used, and adjustment but also to a large extent on the technical equipment used. Utility values may differ depending on kind and appearance of the article and permit low and medium stress applications (e.g. for bedrooms and sitting rooms) and even very heavy stressing (e.g. in public buildings).

Using pile sinkers 7 mm high in a 7 F-gauge machine, a stitch length of 2.5 mm, and textured polyamide continuous filament yarn as the pile material, a stitch-bonded fabric can be formed which, if treated with a full back finish, can be used for wheel-chair stressing which is considered the heaviest stressing at all.

In addition to showing such test results which classify the stitch-bonded fabric as suited for wheel-chair stressing, the fabric has other good properties such as

1 - high resistance to compressive stress, both static and dynamic. That means that the face of the fabric does not show any changes when it is walked over, not even if walked over very frequently.

2 - rapid recovery of the pile tufts following static compressive stress (e.g. by table or chair legs) owing to the fact that the pile loops are intermeshed in a very favourable way;

3 - homogeneous and attractive appearance of the face of the cloth, which is especially appreciated for fabrics covering the floors of theatres, hotels, conference rooms, schools etc. The appearance of Malimo floor coverings is advantageously influenced by mouline effects of the pile yarn; i.e. the pile yarn consists of two differently coloured single threads. Colour combinations can be achieved that cause the dirt on the face of the carpet to be difficult to discern. A particular property of Malimo floor covering is its easy care property. Because of the regular structure of the pile tufts vacuum cleaners will clean the fabric thoroughly within and extremely short time.

2. Finishing of Schusspol floor covering material

2.1. General

The following explanations on the finishing of Malimo floor covering material proceed on the principle that the sewing-knitting machine produces a grey fabric requiring the same finishing processes as any other fabric formed according to the known thread bonding techniques. The great experience acquired in production have proved that the finishing methods used in practice may also be applied to the finishing of Schusspol grey fabric.

The decisive influence to be taken by the finishing methods on the utility value and the appearance of textile floor coverings is not a special requirement inherent in the technique of fabric forming described here, but is a general requirement that must be met by all the highly efficient new techniques known so far. The user calls for an easy-care textile floor covering easy to lay and with good non-skid properties, high resilience, and sufficient sound and heat insulation. In addition, users make requests for special patterns and colours with high uniformity and fastness levels. Malimo type Schusspol stitch-bonded fabrics can be finished according to different variants (Table 4). Thus, the finishing of textile floor coverings is a task that may be fulfilled only by means of up-to-date chemical processes.

2.2. Back coating

For woven carpets, back finishing is of secondary importance. The application of a mixture of starch and glue solely serves the purpose of giving the carpet a better handle and improved non-skid properties. It does not substantially contribute to increasing the service life and attaining a certain utility value. The process requires relative little machinery. For a great variety of woven carpets the low expenditure is even fully dispensed with, and the customer is offered a carpet without any back finish.

Unlike woven carpets, the back-coating of textile floor covering manufactured according to modern techniques is a must. The significantly greater expenditure of finishing not only ensures a high utility value, but imparts properties to the floor covering material that cannot be achieved with woven fabrics finished according to standard methods.

Table 4

Grey fabric with spin-dyed or printed pile material
Coating
Making-up
Grey fabric with undyed pile material:
Dyeing
Coating
Making-up
or

Printing	Coating
Coating	Printing
Making-up	Making-up

Back coating also plays an important part for textile floor covering made according to the sewing-knitting technique. If textured polyamide continuous filament yarn is used as pile material the individual filaments must be firmly bonded to the backing to avoid the well-known pilling formation. This is achieved by means of a synthetic material dispersion, which causes the weft and pile materials to be bonded so intensely that the face of the fabric will not pill, not even under severest stressing. If the pile material consists of spun yarn, the Malimo type Schusspol floor covering material need not be subjected to pile bonding unlike the fabric made according to the tufting technique.

The step which comes next is the back coating proper imparting important properties to the floor covering such as slip resistance, resistance to cutting, resiliency, sound and heat insulation, and dimensional stability. The materials used are polyvinylchloride, natural latex, synthetic latex, and blends of natural and synthetic latices.

Owing to the great variety of fabric weights, different characteristics of the chemicals used, and the wide range of coating processes it is inappropriate to quote recipes in this paper. The recipes recommended by suppliers are a sufficient basis for the expert to enable him to provide for the desired back coating.

It is by far more important to set up a production plant permitting the application of latices and synthetic material dispersions to realize the three most important coating processes, i. e. plain-spread coating, cellular foam and low-porosity foam coating. There are several textile machine manufacturers who have constructed special continuous plants for the coating of textile floor covering material. The basic equipment of such a plant comprises a series of special units which can be combined for the specific purpose in question. Special significance is put on fabric tensioning to obtain a low-tension and low-distortion final product. For in-process cloth storage in case of bale or roller changing the plant must be equipped with a roller compensating unit for a J-box. The take-off and fabric compensating units should be fitted with controls to feed the fabric centrally into the machine.

In the first back coating step the pile tufts are bonded according to the padding process. A dispersion of synthetic material is applied by a padding roller to the carpet back. The padding unit must be designed so as to control the amount applied and the penetration. The speed of the padding roller must be infinitely variable to permit the regulation of the amount of dispersion applied. Application of the dispersion can additionally be controlled by the sense of rotation of the padding roller and by the proportioning doctor blade. Fitting the plant with a double padding mechanism is unnecessary for the application process described, because the amount of coating compound is relatively small. A pre-drier serves to pre-dry the first coat.

If the intended end use calls for a non-cellular, plain latex coating a second padding unit is sufficient to apply the dispersed latex in a second coating step. The following explanations, however, proceed from the fact that amounts exceeding 1000 g/sq.m. (in dry condition) are applied and the most difficult coating process, i. e., low-porosity foam coating, is employed. To realize the second step in back coating a two-step system has been introduced in practice, i. e. base coating/finish-coating. Base coating is effected by means of a single-roller padding unit. This process is not only recommended for reasons of pricing, but also contributes to stabilize the fabric, to increase the fabric weight, improve its handle, and to prevent the foamed compound from penetrating to the pile surface. Since base-coating does not contribute to binding the pile tufts the normally employed amount of filler may be considerably increased. To control the amount of coating compound applied the padding roller speed must be infinitely variable and the proportioning doctor blade adjustable. The base coat is pre-dried before the foamed coat is applied.

The further sequence of operations in the coating process (foam coating) does not differ from the techniques known from practice. To avoid contraction in width the fabric is guided by a stenter chain. Arranged in the feed zone of the stentering frame is the doctor blade unit for foam application. The coating thickness is determined by an adjustable doctor blade, and uniformity in coating across the whole fabric width is ensured by passing the fabric over a doctor beam.

Attachments include driers to allow the foam to gelatinize and an embossing device as well. Such attachments are required if gelatinized foam is to be applied, or the foam is to be embossed in gelatinized condition.

A stentering and drying frame should be used if the foam is to be vulcanized. A cooling zone is required at the drier delivery end before the fabric is unneedled from the stenter chain in order to prevent changes in dimensions and to cool down the pile material to ambient temperature before the cloth is wound up. A complete continuous plant further comprises finished goods storage facilities, fabric inspection table with control device, edge trimming device, and a rising roll batcher or centre batcher. Some selected technical data of a coating plant can be seen from Table 5.

Table 5

Nominal width in mm	3,600 to 5,200
Working width in mm	1,00 to 3,400
Machine speed in m/min	1 to 10 (infinitely variable)
Operating voltage	380 V
Control voltage	220 V
Steam pressure in kgf/sq.cm.	10 to 16
Steam requirement (basis : 11 kgf/sq.cm.) in tons/hour	3.5
Capacity, in KW	350
Cooling water requirement	5 cubic metres/hour
Space requirement in sq m.	some 500

The machine speed essentially depends upon the dry substance and vulcanization time of the compound, the amount applied per unit area, the air permeability of the textile fabric, and the heating capacity of the driers.

Accurate data cannot be given because of the many variables. In practice, the machine speeds employed range between 2 and 6 metres/minute.

To realize the technological process in an economical and flexible way with a constant quality being maintained and using a high-efficiency coating plant, another plant is required to prepare the back coating compound. It can be noted here that manual preparation is more and more replaced by an automatically controlled process.

The preparation plant comprises the functional units below:

1. Filler hoppers with pneumatic feed devices
2. Latex tanks with agitators, pipe lines for the coating compound, and compressed air lines for discharge

3. Preparation tanks for fillers and solvents
4. Mixers for paste preparation, and
5. Storage areas for other chemicals.

The compound is pumped into a storage tank so that the next batch can be prepared. For compound foaming, a fully automatic foam mixer is employed. The continuous process permits exact and uniform standardization.

2.3. Colouring

This finishing process comprises dyeing and printing. The initial product is the stitch-bonded fabric with the undyed (natural white) pile.

Experience gained in this field is still incomplete, but there is no doubt that the processes used in practice for textile floor covering material may be applied to Schusspol sewn-knit fabrics alike. Development has shown that the demands made by the user in regard to fashionable designing are ever increasing.

Carpet printing has found great interest on the grounds that solid-effect piece-dyeing, differential dyeing, and the TAK process primarily impart colour to the fabric face, but yield a pattern to a limited extent only.

A great number of European machine builders have been engaged in the construction of carpet printing machines for the past years. The highest technical level was achieved with the development of flat-bed stencil printing. The flat-bed stencil printing machine operates without any problems and has proved to be suited for permanent operation.

However, flat-bed stencil printing has certain limits which restrict the application of this process:

1. The length of repeat is limited to about 92.4 cm;
2. Owing to intermittent printing long retention periods occur on the printing table before the printed fabric enters the steam-box.
3. The space required for the printing machine and for the handling of the huge stencils is relatively large.
4. To ensure proper printing penetration, several doctor strokes are necessary. The forces occuring may cause the carpet to be shifted and, consequently, result in an inaccurate registration.

It has been especially in Europe that some carpet printers have practiced rotary stencil printing. The rotary stencil printing machine expands the range of applications and, to its manufactures opinions, is well-suited both for printing wall-to-wall floor coverings and carpets having large pattern repeats. It is a continuous process requiring a very short time between dye application and developing or fixation, and permitting intricate patterns to be printed.

Rotary printing machines yielded very good printing results with Schusspol stitch-bonded fabric. By choosing appropriate dyestuffs and thickeners, suitable printing paste viscosities, taking into account dye penetration through the stencils, and controlling the steaming process the printing results obtained already now are such as to meet high pretension with regard to design and colour.

3. Conclusions

It has been proved that textile floor covering material can be manufactured according to the Malimo sewing-knitting technique type Schusspol to meet the most different requirements with regard to versatility in design, shape and colour. Since the advent of Malimo many branches of textile industry have been revolutionized by this technique, and a new era has also been inaugurated in the field of textile floor covering materials.

Part 4
Technical possibilities and technology of types Maliwatt and Malivlies

0. Preface

The first type of MALIMO sewing-knitting machine employed as a production machine in the textile industry was the Maliwatt type. Tested on a laboratory scale in 1953, this machine was used in the light industry only one year later. It had taken four years to realize on an industrial scale the basic patent of the MALIMO sewing-knitting technique by National Price Holder Ing. Heinrich Mauersberger in the machine model 14001. In 1957 such a machine was introduced to the public at the Leipzig Spring Fair for the first time. Export started in the same yaer.

The Malivlies type, however, was born at a substantially later date. In 1959 a first patent for the manufacture of stitch-bonded fabrics made of loose fibre material was filed. In 1967, when the first production machine was handed over to the textile industry, the Malivlies technique was employed on an industrial scale for the first time. Since that time a largely variable program of sewing-knitting machine designs meeting the most diversified requirements of the textile industry has been developed also for these two types. Most of the MALIMO sewing-knitting machines of the Maliwatt and Malivlies types are now operated continuously, i. e. fibre-web forming and sewing-knitting machines are electrically and mechanically interlinked.

To distinguish between the Maliwatt and Malivlies techniques it is necessary to consider the sewing-knitting process. Generally it can be said that the sewing-knitting technique involves one or several fed media which are stitched by the points of needles arranged in a line and operating simultaneously. In doing so, the needle hooks are temporarily closed to form stitches. During the sewing-knitting procedure the media are consolidated and their properties changed.

The fed medium which is to be stitched, may be a parallel laid, cross laid or random laid fibre web or a sliver web. For Malivlies, cross laid fibre sheets are required in most of the cases for production-technological reasons, however, for Maliwatt, too, a cross laid fibre web is usually employed. In special cases it is possible to overstitch foils, woven fabrics, knit fabrics, paper and foamed plastic webs (Maliwatt). However, it is also possible to stitch-bond the latter to fibre webs.

The main difference between the two techniques lies in the fact that, with the Maliwatt technique, consolidation for obtaining the textile fabric is effected through stitching threads worked into a fed medium in plain chain stitch or interlocking chain stitch, whereas, with the Malivlies technique, fibres of the web itself are converted into stitches to bring about the required increase in strength.

While with the Maliwatt technique the proportion of nonspun fibre material is between 80 and 95 %, dependent on the machine gauge and product, for Malivlies no spun yarns at all are required for consolidation. The products of these techniques are called stitch-bonded fibre web (Maliwatt) fabric and intermeshed fibre web (Malivlies) fabric, respectively.

1. Mode of operation of the MALIMO sewing-knitting machines types Maliwatt and Malivlies

1.1. The stitching area

The sliding needle – closing wire-system acting in connection with the knocking-over sinker exists with both types to stitch the fed media. The stitching threads required for the Maliwatt technique, are laid into the opentype eyes of sliding needles by means of guide needles and formed into stitches which pierce the fed medium. One and two guide bars as well as plain and interlocking chain stitches are possible. The retaining pin in connection with the front guide bar prevents the fibre web from being displaced. In the case of interlocking chain stitch, the stitching yarn is laid over the retaining pin and with drawn in front of the front guide bar. With this type of chain stitch it is possible to interlace and additional longitudinally parallel warp component.

With the Malivlies type, laying-in sinkers prevent the web from being displaced when stitching forward. When the sliding needles move back transverse fibres from the front side of the web are caught by needle hooks, arrested by closing wires, and drawn through the web. By drawing these fibres through the half stitch still hanging on the needle shaft (knocking-over), a knit fabric-like appearance of stitches is obtained on the back of the web.

The quality of the stitch-bonded fabric depends largely on the precision of the individual elements in the stitching area. For gauge 22 F on the 14010 model, and on principle, for the 14013 model, heat compensation attachments are provided which provide for a controlled, largely uniform displacement of the bars during heating-up. In addition, bar heating is employed for the 14013 model to compensate differences in temperature between the individual bars in the operating condition ar far as possible.

1.2. Structure of the sewing-knitting machine

The MALIMO sewing-knitting machine, types Maliwatt and Malivlies, may be subdivided into four main functional units: fibre web feeding mechanism, stitching-yarn feeding and control mechanism (for the Maliwatt type only), stitching zone and fabric take-up and storage mechanism.

The traditional type of feeding the web shown in Fig. 3 is hardly used any longer nowadays. With this discontinuous type of feeding, wound laps having a maximum running length of 50 m are laid on a rubber apron, rolled down and fed to the stitching zone. Various problems such as stoppage times for joining the web, variations in the weights per unit area (at the joints), wear phenomena (in the joining areas), handling and storage processes, or spaces, respectively, and the lack in possibilities for the lapping and rolling down of certain materials (e. g. thin webs) according to quality requirements, gave rise to the development of the widely accepted continuous mode of operation, where the web is directly fed to the stitching zone by the fibre web former, and processed.

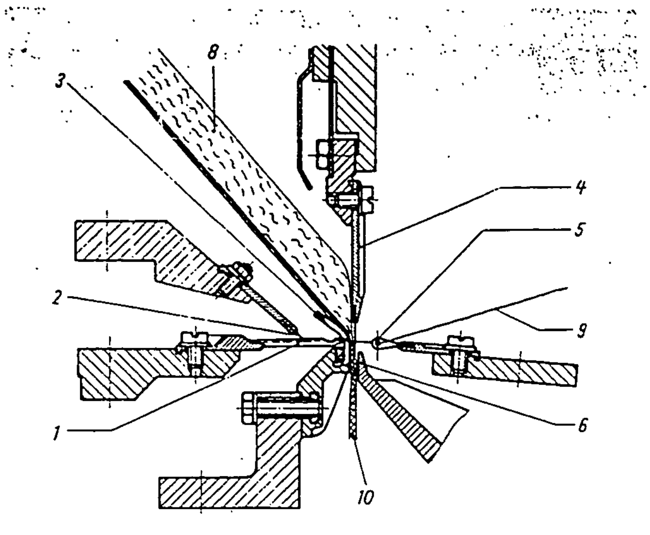


Fig. 1 Stitching area of the MALIMO sewing-knitting machine type Maliwatt with one guide bar Stitch-bonding elements:
1 sliding needle, 2 closing wire, 3 knocking-over sinker, 4 retaining pin, 5 stitching yarn guide, and 6 front guide bar.
Working media and finished product:
8 fibre web, 9 stitching thread and 10 thread-web stitch-bonded fabric

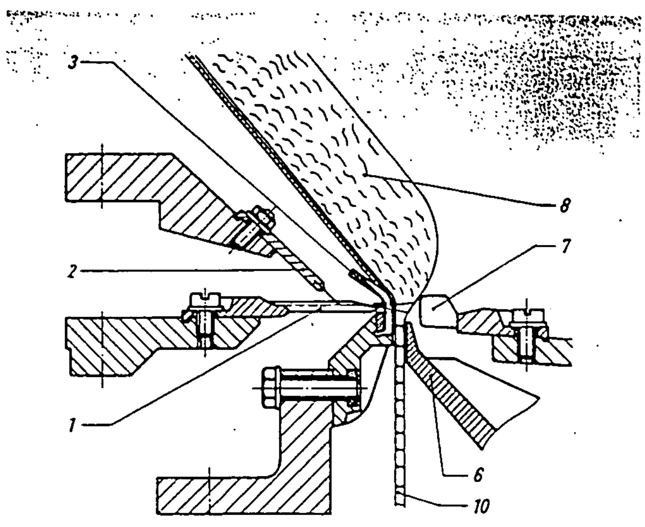


Fig. 2 Stitching area of the MALIMO sewing-knitting machine type Malivlies (for designations see Fig. 1)
Stitch-bonding elements: 7 laying-in sinker
Working media and finished product: 10 intermeshed fibre web

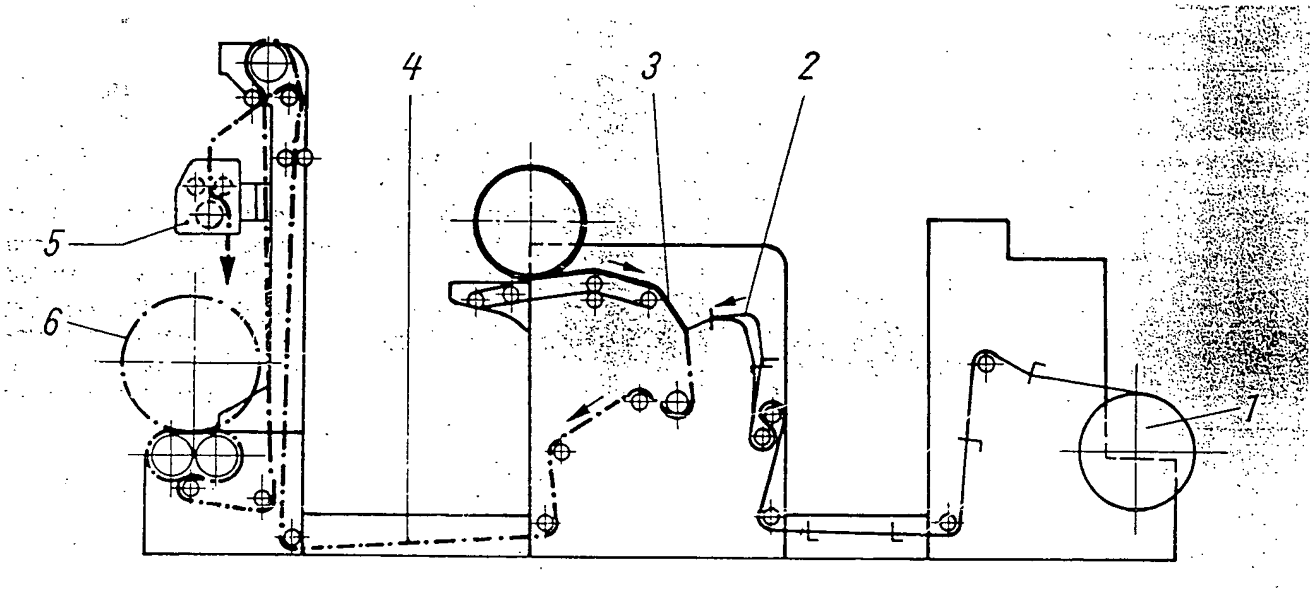


Fig 3 Schematic view of material passage (type Maliwatt, modell 14010): 1 stitching yarn beam, 2 stitching yarn, 3 fibre web (discontinuous feeding), 4 stitch-bonded fabric, 5 breaker for cut-off edges, 6 cloth lap

The stitching thread required for the Maliwatt machine is fed either from the warp beam winding-off stand or from the bobbin creel. According to experience, bobbin creels are employed with machine gauges up to and including 10 F (10 needles per 25 mm) only, as for higher gauges the bobbin creels require too much floor space On the other hand, lower gauges are often unfit for warp beams, as the specific loading of the thread increases so that it becomes difficult to obtain a regular warp beam winding.

Further specific features of the stitching-yarn feeding mechanism: use of full-length or sectional warp beams possible, thread braking through ordinary or automatic band brake (tension and diameter controlled), warp beam drive possible, thread guidance through thread guide plates, yarn feeding device with stepless speed adjustment, and drop detector stop motion with transistor gain.

The stitch length can be adjusted in steps from 0.55 to 5.0 mm per course of stitches. The stitch-bonded fabrics may be stored on laps (Fig. 3) or in staples, and a difference in speeds ranging from −8 to +15 % relative to the fabric take-up can be adjusted. The fabric selvedges that cannot be used are separated by means of rotary knives provided on the sewing-knitting machine or on the storage device. At the same time the stitch-bonded fabrics can be cut several times in the longitudinal direction. The cut-off selvedges of stitch-bonded fabrics are fed to breakers which, by means of rotors running at a speed of about 3000 r.p.m., break up the fabric into its fibre components as far as possible. In a great number of cases, these raw materials may be reused for the manufacture of webs.

2. Technical variability of the Maliwatt and Malivlies types

Maliwatt and Malivlies-type machines are made in the models 14010 and 14013 (Table 1). The efficiency and performance are largely dependent on the material, the type of product, and the conditions of production.

3. Development of the machine systems

After the Maliwatt technique had been introduced, the textile industries and the machine building industries at home and abroad started with experiments to interlink fibre web formers and sewing-knitting machines. The technical level of the experiments was different, the object however, was the same: high productive capacities with optimum quality parameters, a decrease in labour force requirements, a decrease in the cost of labour, economization of production and storage areas, reduction in power costs, ease of maintenance and operation.
It was the scientifico-technical cooperation between the firms Befama, Bielso-Biala (Poland) and VEB Nähwirkmaschinenbau Malimo, Karl-Marx-Stadt, which provided the basis for the successful development and testing of coordinated machine systems and their introduction to the textile industry.

3.1. Construction of the machine systems

For instance, a customery Befama-Malimo type Maliwatt machine system comprises the following units: weigher hopper feeder, feeding unit, licker-in, card, transfer mechanism, horizontal web laying device, compensating device and Maliwatt type sewing-knitting machine. These systems are so interlinked mechanically and electrically that it is possible to make the textile fabric, starting from the fibre, in one process. The control systems of the Maliwatt-type machine systems are designed such that, e. g. in these case of thread breakage, the sewing-knitting machine is stopped immediately whereas the fibre web former continues to operate for a certain time (gyrating mass). The web produced during this time is fed to a store. After the sewing-knitting machine has been restarted, this store (compensation unit) is emptied automatically.
The working speeds of the individual units are synchronized. For the Befama-MALIMO type Malivlies machine system (M 2/2400), interlinking is effected through a synchronous control circuit i. e. slip-ring motors with synchronized speeds. This ensures the coordinate starting and stopping, i. e. a stable condition of operation of the machine system.

Table 1 Survey of the most important technical parameters

Parameter	Model 14010 Type Maliwatt	Type Malivlies	Model 14011 Type Maliwatt	Type Malivlies
Nominal width mm	2400	2400	3600	3600
Working width, mm	2500 max.	2500 max	3700 max	3700 max
Range of gauge, $\frac{1}{25\text{ mm}}$	3.5 to 22	3.5 to 22	3.5 to 22	3.5 to 22
Speed, r.p.m	500 to 1500	500 to 1500[2] 500 to 1100[3]	750 to 1500	750 to 1500
Floor space requirement, m^2 (sewing-knitting machine without fibre web former)	21	16	35	29
Connected load, kW	6	6	16	16
Weight of sewing-knitting machine kgf (operation weight)	6800	5200	10500	8000

[2] Weight per unit area of finished product max. 250 g/m^2
[3] Weight per unit area of finished product exceeding 250 g/m^2

3.2. Details concerning the fibre web forming section

Usually machinery and devices for the preliminary opening-up of the fibres into a fluffy mass and mixing as well as for the addition of chemical auxiliaries (oiling agents or anti-static agents) precede the actual machine system. Material transfer between them is effected pneumatically with certain processes such as opening, being carried out several times, if necessary. The better the preliminary breaking-up, the more uniform the final product will be. The feeding to the first machine of the machine system, i. e. the hopper feeder, is also effected pneumatically via a cyclone or by gravity through a rectangular tube. The hopper feeder has the task to feed to the card preselected quantities of fluffy fibre mass at certain intervals of time, thus determining the throughput. A large raw material container and a precise weighing are favourable. The feeding unit and licker-in are followed by the actual main unit, i. e. one or several cards. Their number depends on the pretreatment of the fibres and the required uniformity of the fibre web. The roller cards of Messrs. Befama have a main drum diameter of 1500 mm, four to six pairs of workers and clearers, one or two doffers, and roller widths of 1800, 2000, 2200 or 2500 mm. They may be equipped with flexible clothings or all-steel clothings. Belt conveying units for transverse and longitudinal fibre feeding are arranged between the cards.
The card is followed by a horizontal fibre web laying unit which has the task to transfer the thin fibre web obtained from the doffer of the set of cards, and to place it onto the collecting lattice, running at a right angle to the same, in the required width and weight per unit area. The delivery lattices of the Befama web laying unit have a speed of up to 30 m/min, the collecting lattice has a speed of no more than 9 m/min whereas the number of web layers is 6 to 48. It must be noted that, with an increasing number of web layers lying one upon the other, the uniformity of the composite web increases. Befama web laying units are manufactured with collecting lattice widths of 2000, 2700, 3200, 3800, and 4200. In Maliwatt systems at least, the compensation unit is used, between the web laying unit and the sewing-knitting machine. In Befama-MALIMO machine systems having a nominal width of 2400 mm a lattice store is used, and in systems having a width of 3600 mm a trough-type store. For Malivlies, on principle, a delivery lattice to the sewing-knitting machine is sufficient. However, as in the textile industry in many cases it is desired to use the systems for Maliwatt and Malivlies alternatively, machine systems having a nominal width of 3600 mm, for instance, are basically provided with compensation unit and an appropriate means of control.

4. Production-technological possibilities of the Maliwatt and Malivlies types

The production-technological possibilities of the two types of machines are multifarious and have by far not been fully utilized. A decisive factor, amongst other things, is the great number of possible variants with regard to machine gauges (22/18/14/12/10/7/3.5 needles per 25 mm), working widths (model 14013 3700 mm max.; model 14010 2500 mm max.), stitch lengths (0,55 to 5.0 mm in 24 steps), number of guide bars (1 or 2), type stitches (interlocking chain stitch/plain chain stitch), fibre web (fibrous material, count of fibre, length of fibre, crimp of fibre, fibre orientation, web structure, weight of web), and stitching thread (material, thickness, strength, elasticity), with all these applying to the Maliwatt type, and the criteria machine gauge, working width, length of stitch and fibre web only applying to the Malivlies type. From the Tables 2 and 3 the essential general data to the main criteria related to the most commonly used machine gauges, can be taken. A bar in a field has the following meaning: for reasons of machine engineering and textile production technology, work under the given conditions is extremely critical, or impossible, respectively. Empty fields have the following meaning: Work under these conditions is possible, however, the authors are not in the possession of well-founded data.

It is the task of the textile production engineer to fully use the production-technological possibilities of the sewing-knitting machines, to combine them efficiently, and to develop appropriate serviceable products, including all the possibilities offered by modern methods of textile finishing. The significance of the development of Maliwatt and Malivlies products lies not only in the substitution of conventionally made textile fabrics, but also in the fact that, by means of the sewing-knitting techniques Maliwatt and Malivlies, products of new or better qualities can be developed.

The textile-physical parameters breaking strength and elongation at break depend mainly on the machine-technological parameters such as machine gauge, stitch length, and type of stitch (Maliwatt), as well as on the production-technological factors weight of web, web material and stitching yarn used (Maliwatt). In a roughly simplified manner it can be said that a greater strength in the transverse direction can be obtained mainly by reducing the length of stitch, increasing the weight per unit area, or machine gauge, respectively, by using web materials of a higher strength and fibres of greater staple length, whereas the longitudinal strength can be increased by increasing the machine gauge and using stitching threads of a higher strength (Maliwatt).

The bulkiness of the Maliwatt and Malivlies products decreases with increasing machine gauge, however, at the same time the fibre covering (Maliwatt) and fibre bonding (Malivlies) increase.

Fig 4 Machine system Belama-MALIMO, type Maliwatt N 3600

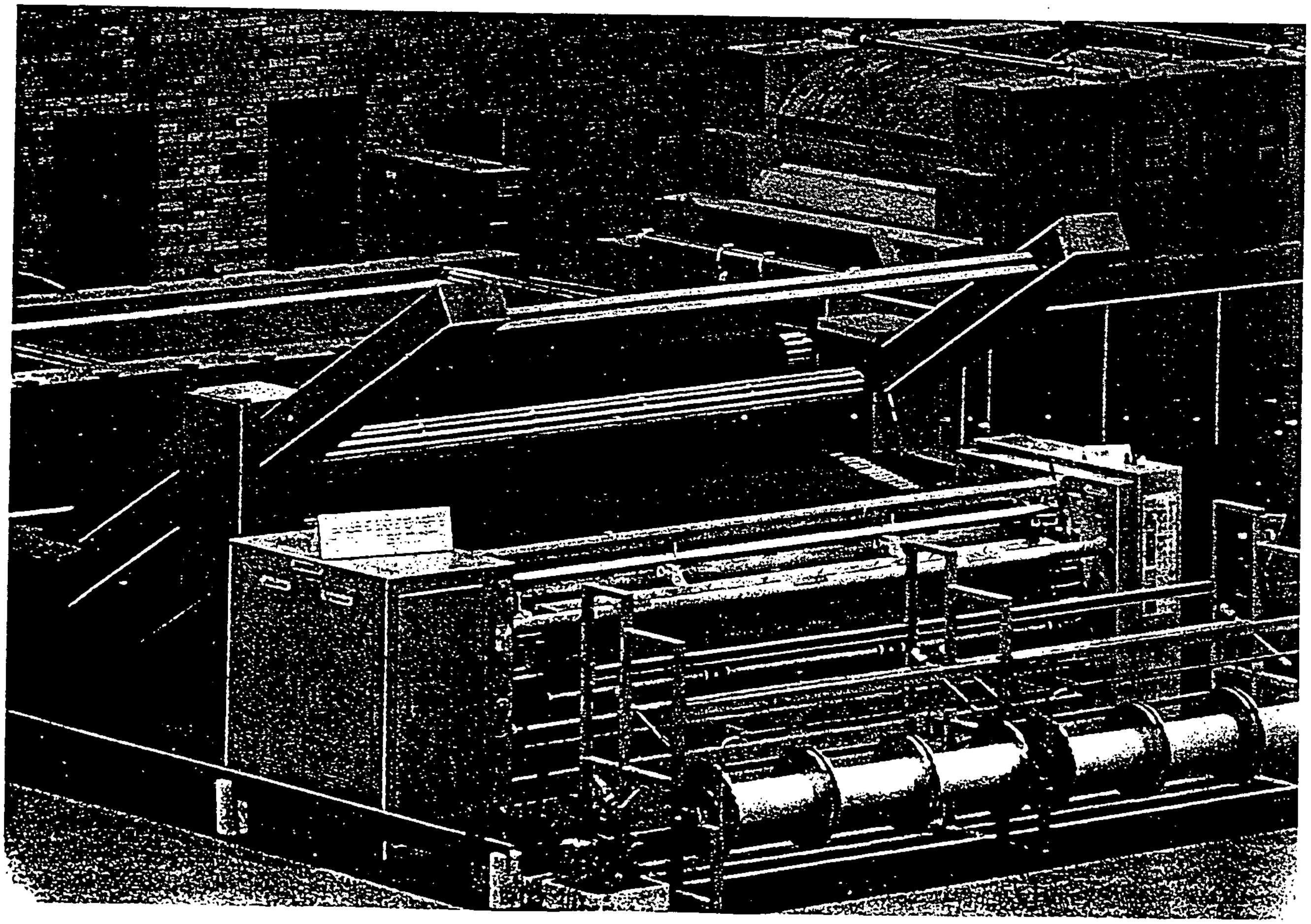


Table 2 Production-technological possibilities of the Maliwatt type

MALIMO sewing-knitting machine type Maliwatt	Machine gauge (needles per 25 mm) 3.5 F	7 F	10 F	14 F	18 F	22 F
Practical length of stitch[4], mm	2 to 5	2 to 5	1.2 to 3.5	0.9 to 2.5	0.55 to 1.5	0.55 to 1.2
Type of stitch[5]	T/F	T/F	T/F	T/F	T/F	T/F
Number of guide bars	1	1	1 or 2	1 or 2	1	1
Gauge of sliding needle[9]	m	m	m	f	sf	sf
Weight per unit area[6] g/m^2 of the sitch-bonded fibre web						
when processing the fibrous materials[7]:	200 to 500	200 to 400	150 to 350	150 to 300	100 to 230	100 to 160
Viscose stable fibre, polyacrylonitrite fibre						
Polyester fibre, polyamide fibre	200 to 350	200 to 300	150 to 280	150 to 250	100 to 200	100 to 140
Reclaimed material (Rm)	200 to 500					–
35 per cent cotton, 40 per cent reclaimed material, 25 per cent viscose staple fibre[8]		200 to 320	–	–		–
Glas fibre/asbestos[8]	500 to 1000	–	–	–	–	–
Stitching yarn count in tex when processing:						
Polyester filament, polyamide filament, rayon	100 to 17	100 to 17	100 to 17	17 to 6.8	11 to 4.4	1 to 4.4
Yarns of cotton, viscose staple fibre, polyester fibre	50 to 25	50 to 25	50 to 25	30 to 17	30 to 17	–

Table 3 Production-technological possibilities of the Malivlies type

MALIMO sewing-knitting machine type Malivlies	Machine gauge (needles per 25 mm) 3.5 F	7 F	14 F	18 F	14 F	22 F
Practical length of stitch[4], mm	1 to 2.5	1 to 2.5	1 to 2	1 to 1.8	0.9 to 1.7	0.9 to 1.4
Gauge of sliding needle[10]	f(m)	f(m)	f	f	f	f
Weight per unit area[6], g/m^2 of the intermeshed fibre web						
when processing the fibrous materials[7]:	160 to 600	160 to 550	160 to 450	160 to 400	160 to 300	120 to 250
Viscose staple fibre-wt						
Polyacrylonitrile fibre-wt	160 to 500	160 to 400	160 to 380	160 to 350	160 to 280	120 to 200
Polyester fibre	160 to 350	160 to 300	160 to 280	160 to 250	160 to 200	120 to 170
Polyamide fibre	180 to 250	200	–	–	–	–
50 per cent wool/50 per cent viscose staple fibre[8]		300			–	
80 per cent reclaimed material/20 per cent viscose staple fibre		300 to 400				–

[4] Theoretical range of stitch lengths of the sewing-knitting machine: 0.55 to 5 mm
[5] T ≙ interlocking chain stitch; F ≙ plain chain stitch
[6] Weight per unit area = fibre web + stitching yarn; given values are related to grey fibrous materials.
[7] Customary fibre count: 340 to 880 m tex (It is possible to process portions of coarser and finer fibres, but this requires a reduction in the maximum weight per unit area).
[8] Mixtures of fibrous materials
[9] m ≙ medium, f ≙ fine, sf ≙ very fine
[10] f ≙ fine, (m) ≙ medium gauge possible

4.1. Well-known and newly developed Maliwatt products

The variety of different nonwoven textile fabrics made according to the oldest sewing-knitting technique, the Maliwatt technique, ranges from industrial textiles to clothing materials, from imitation leather backing cloth to draperies. New fields of application are opened up continuously (Table 4).

4.2. Well-known and newly developed Malivlies products

There are still plenty of possibilities to develop new products which are based on the Malivlies technique. It must, however, be taken into consideration that Malivlies products have lower strength and higher elongation values as compared with Maliwatt products. These disadvantages are compensated by the extremely economical manufacture of Malivlies products, as the fibre web is consolidated without the use of any yarn material. This results in a high efficiency of the sewing-knitting machine (no thread breakages, no stoppage times for warp beam or bobbin changes), no costs for yarn spinning and, in addition, there are optimum conditions of work for the operating personnel as, in general, the machines require merely a supervising hand. Malivlies products are mainly used where strength is not required but other requirements have to be met (e. g. sound and heat insulation). And yet it is possible to extend the application of Malivlies products by additional chemical or thermal consolidation , by bonding or welding them to substrates (e. g. woven materials, knit fabrics), and by the processing of shrink fibre webs. In Table 5 part of the Malivlies products presently produced are shown.

5. Trends

The stitch-bonding techniques including the Maliwatt and Malivlies techniques are relatively young compared with the traditional techniques of textile fabric formation such as weaving and knitting and are, therefore, provocative of extensive technological and production-engineering development. Such development work necessites the intensive cooperation of machine, builders and textile production engineers, special importance having to be attached to the utilization of the specific advantages.

The sewing-knitting machine with its main parameters machine gauge, length of stitch, working width, and speed, greatly influences the qualities of the products and the profitability of the production process.

The machine gauges were extended in steps from 3.5 and 7 F through 14 F and 18 F to 22 F. At present the latter is a limit set up by economical factors rather than by machine-technological factors, as with increasing machine gauge the proportion of fibre web in the final product decreases and the percentage of the stitching yarn increases. When establishing the working widths and speeds of the machine, the immediate relationship to the efficiency of the fibre web former must be taken into consideration. Light-weight assortments allow great working widths and high speeds whereas heavy items with great lengths of stitches require high-duty cards or possibly the parallel connection of cards. A mediumweight item of 250 g/m^2, for instance, with a working width of 3600 mm, a speed of 1200 r. p. m., and a stitch length of 2.5 mm requires a theoretical output of the cards of 162 kg/h.

Table 4 Survery of well-known and newly developed Maliwatt products

Designation of item	Gauge	Fibre web material	Weight per unit area g/m^3	Main qualities
Backing fabric of floor covering	3.5 F	reclaimed material	500	high bulkiness
Glass fibre mat	3.5 F	glass fibre	1000	good heat insulation
Quilted wadding (interlining)	3.5 F	polyester fibre	270	good heat insulation
Motor car ceilling	7 F	viscose staple fibre	250	good sound insulation good formability
Cleaning cloth	7 F	cotton/reclaimed material/viscose staple fibre	320	good absorbability
Drapery	10 F	polyester fibre	180	woven fabric-like qualities with regard to strength, drape, etc.
Drapery	14 F	viscose staple fibre	160	
Slipper uppers	18 F	viscose staple fibre	230	good formability
Slipper uppers	18 F	polyacrylo-nitrile fibres	230	high strength
Imitation leather-backing fabric	22 F	viscose staple fibre	120	good density and uniformity
Diaper mull	22 F	viscose staple fibre (animalized viscose)	100	high absorbability together with a high strength
Dress material	22 F	viscose staple fibre/ polyacrylo-nitrile fibre	140	woven fabric-like qualities

Table 5 Survery of well-known and newly developed Malivlies products

Designation of item	Gauge	Fibre web material	Weight per unit area g/m^2	Main qualities
Interlining	3.5 F	polyamide fibre	190	perspiration-absorbend, heat insulating
Wall-to-wall covering lamination material	7 F	reclaimed material	370	high bulkiness
Polishing cloth	14 F	viscose staple fibre	200	soft
Drapery felt	18 F	viscose staple fibre/	270	good formability
Base fabric for Voltex	22 F	polyacrylo-nitrile fibre polyester fibre (portions of animalized viscose)	170	high strength
Imitation leather-backing	22 F	polyester fibre/viscose staple fibre	170	high strength

However, greater widths of machines in most of the cases permit a more economical utilization of the working width by making several widths of fabric on one machine. If the product requires the entire width, then the equipment must be dimensioned accordingly. The economical speed of the sewing-knitting machine depends on the properties of the fibre web material (especially in the case of Malivlies) and the running qualities of the stitching thread.

An increase beyond the present maximum speed of 1500 r. p. m. requires solutions with regard to the control of the stitching forces at the stitch-bonding elements and of the frictional heat mainly occuring with Malivlies. In spite of the existing high degree of automation of the sewing-knitting machine as well as the machine system, there are still reserves left for a further increase in efficiency and a reduction in operational expenditure. As regards machine systems, the working width and efficiency can be further increased by employing large-capacity hopper feeders, cards of a higher output, web laying units with a high speed of passage. The use of appropriate measuring devices (measurement of the weight per unit area by means of isotopic measuring devices or photoelectric inspection of the web) will help to further improve the quality and to decrease the expenditure of control.

The patterning of stitch-bonded fabrics will be carried out on the sewing-knitting machine and during the finishing stages (printing, dyeing, raising, embossing etc.) in future. In addition to the patterns that are possible at present, such as striped patterns produced by the omission of stitching threads or by using yarns of different colours as well as by employing plain chain stitch or interlocking chain stitch, the MALIMO sewing-knitting machine type Maliwatt enables the development of a patterning mechanism for the control of one or two guide bars. Thus, not only pattern effects but changes in the properties (strength, elongation, volume) of the stitch-bonded fabrics can be obtained as well.

Furthermore, there is a possibility of combining the Maliwatt and Malivlies techniques to form fibre and yarn stitches at the same time, and to obtain certain pattern effects or the retardation of ladders of the stitching thread. The material processed on the first Maliwatt machines was nearly always reclaimed spinning material and cotton yarn. Now the dominating web materials are man-made and vegetable fibre, whereas for the stitching threads synthetic continuous filament yarns are mainly used. However, reclaimed materials are again gaining importance as secondary raw materials, due to the international material situation and environmental control.

The processing of shrink materials in the web and in the stitching thread represents a possibility of positively influencing the textile-physical properties of the stitch-bonded fabrics, due consideration, however, having to be given to economical points of view. Attemps have been made, partly with a certain success, to process new raw materials like asbestos or mineral fibres on the Maliwatt type sewing-knitting machine.

Finishing techniques are increasingly gainging importance in the improvement and modification, respectively, of the properties of the stitch-bonded fabrics. The far-reaching possibilities offered by special finishing techniques can only be indicated: consolidation due to chemical binding agents and solvents, coating with chemical finishing layers, consolidation by thermal processes (fibre fixing or fibre bonding), consolidation and improvement of the elongation behaviour by shrinking, cross and lengthwise stretching as well as surface alternation by embossing, printing, raising (Malivlies), shearing (Malivlies) or calendering.

6. Summary

While the Maliwatt technique as the oldest of all the Malimo sewing-knitting techniques enables the manufacture of nonwoven textile fabrics by the consolidation of fibre webs by means of a large number of stitching threads, the ,,younger'' Malivlies technique permits the consolidation of fibre webs by intermeshing the fibres of the web. The two techniques do not rival one another but complement one another in an ingenious manner as the products in each case have their specific properties.

The MALIMO sewing-knitting machine types Maliwatt and Malivlies are preferably linked with Befama fibre web forming equipment to form machine systems. This interlinking ensures a high efficiency of the sewing-knitting machines and a good uniformity of the manufactured stitch-bonded fabrics. The maximum working width of the Maliwatt and Malivlies types is 3700 mm, the maximum machine gauge 22 F, and the maximum speed 1500 r.p.m. The weights per unit area that can be processed depend on the machine gauge and material and are within the range of 100 to 1000 g/m^2. The output of the MALIMO sewing-knitting machine types Maliwatt and Malivlies is highly dependent on the efficiency, the speed, the length of stitches as well as the quality of fibrous materials, and ranges from 35 to 360 m/h.

Employing the Maliwatt and Malivlies techniques implies the following advantages: low cost of material and prime cost, low power consumption, low labour cost, low labour force requirements, and high productivity. The Maliwatt and Malivlies techniques offer the light industry multifarious possibilities of advancing and newly developing nonwoven textile fabrics. Also in future, the machine building industry will always strive to promote these progressive techniques by continuously improving the MALIMO sewing-knitting machines

Part 5
Technical possibilities and technology of type Malipol

0. Introduction

MALIMO sewing-knitting machines type Malipol are high-duty machines producing single-faced pile fabrics. Pile and plain stitch-bonded fabrics which have gained a certain share in the production of garments, are produced at the high working speed and great economy which are typical of the Malimo stitch- bonding technique.

Textile technologists in many countries of the world are keen on combining many different textile fabrics as base fabric with many kinds of spun yarns, twisted yarns, and continuous filament yarns, in order to achieve expediently structured textiles.

1. Technological potential of the Malipol type

1.1 Structure of the sewing-knitting machine

The Malimo sewing-knitting machine type Malipol can be subdivided into four main functional units:

the pile yarn feeding unit;

the base fabric feeding unit,

the stitching area, and

the fabric take-down and plaiting or winding-up mechanism.

Fig. 1 (schematic diagram of material flow) shows this clearly. The machine is capable of producing fabrics having maximum widths of 1700 mm and 2500 mm. Smaller fabric widths may be stepped at option.

1.2. Pile yarn feeding

The pile yarn is fed from commercial bobbin creels for single or magazin-type creeling-up, or from warp beam stands. The threads are passed from the unwinding unit through underneath the foot treadle to the sewing-knitting machine proper by means of yarn guide plates. A steplessly variable thread feeding mechanism is installed in the thread feeding unit to balance inevitable irregularities occurring with the delivery yarn packages and to pass the pile yarn to the stitch-bonding tools under optimum conditions. So-called yarn tensioners ensure that the thread, when fed to the stitching needles, is always well tensioned.

The adjustability of the feeding mechanism and the yarn tensioners provides for optimum processing conditions for almost all types of spun yarns, twisted yarns, and continuous filament yarns which the machine gauge permits to process. In case of yarn breakage, the machine will be stopped by an electronically functioning lamina-type stop motion installed within the yarn path.

1.2.1. Feeding from the warp beam stand

Feeding from the warp beam stand involves the following advantages:
- little floor space required (Table 1)
- uniform appearance of the fabric
- multiple machine attendance.

The disadvantages are:
- separate preparation of warp beams
- reduced efficiency owing to warp beam changes
- use of one yarn thickness only

The disadvantages can be compensated by using a warp beam stand with two unwinding stations. Warp beams having a maximum flange diameter of 800 mm may be used.

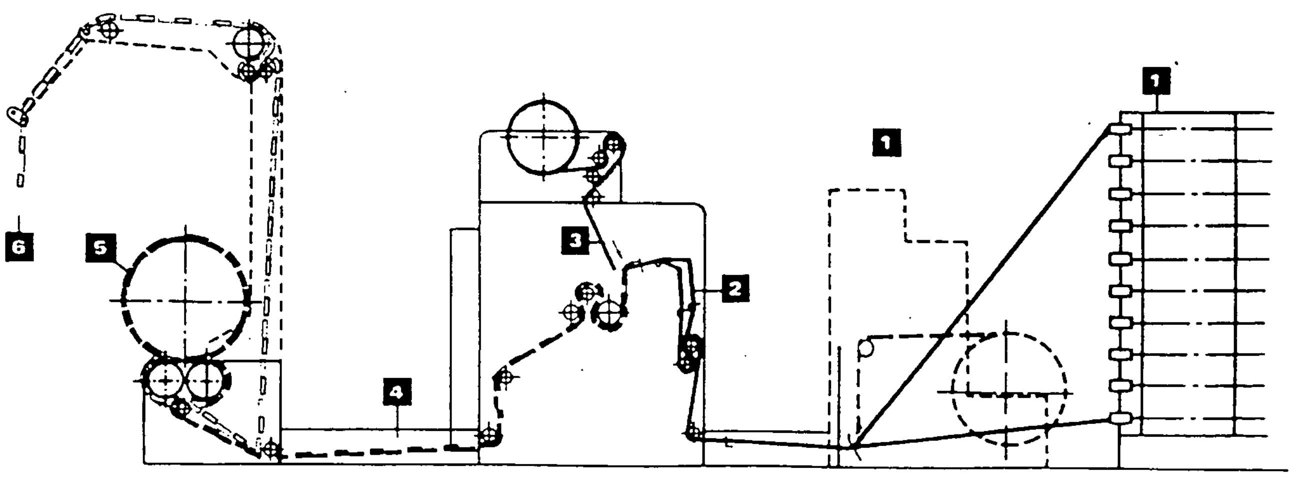
Tables and Figures

Table 1 Net floor space required in m^2

Nominal width of machine	Gauge	With bobbin creel Design B (single) 700/180	900/180	Design F (magazin) 400/180	500/180	400/220	With warp beam stand
N 1600	10	46	–	94	–	117	18.5
	12	–	53	–	126	–	
	14	–	–	–	126	–	
N 2400	10	82	–	–	129	–	24
	12	82	–	–	–	–	
	14	82	–	–	–	–	

Creel model 4161, VEB Schär- und Spulenmaschinenbau Burgstädt
400, 500, 700, 900 winding-off points
180, 220, pitch of the creel

Fig 1 Schematic diagram of product flow
1 warp beam stand or bobbin creel, 2 pile yarn, 3 base fabric 4 stitch-bonded fabric 5 fabric winding-up mechanism 6 fabric plaiting mechanism



1.2.2. Feeding from bobbin creel

The use of bobbin creels increases the floor space requirement many times as compared with the warp beam stand, but it allows to favourably utilize the versatility of the Malipol sewing-knitting machine. Articles may be changed quickly, and several yarn thicknesses may be processed side by side at a time. The running lengths from the bobbins are considerably greater than those from warp beams; if magazine-type creels are used, there will be no stoppage at all. Owing to differences in the hardness of the bobbins and great differences in the yarn paths within the creel, the appearance of the fabric will not be as uniform as that produced when working from the warp beam.

1.3. Base fabric feeding

The base fabric feeding unit supplied with the machine feeds the base fabric from the lap (max. dia. 500 mm) inserted in the machine, to the stitching area via feeding and spreading rollers.

The base fabric (a prefabricated textile fabric) may also be processed from a large batch roll. In this case, the arrangement of the lap truck behind the machine, and feeding of the textile fabric to the machine via the plaiting or winding-up unit is recommended. The use of a cloth control device as employed in textile finishing, is very advantageous.

1.4. Stitching area

The stitching needle and closing wire system in connection with knocking-over sinkers, which is typical of the Malimo sewing-knitting machines, is complemented by pile sinkers. It pierces the prefabricated base fabric.

The sheet of pile yarns supplied is laid in by guide needles, formed into pile loops, and stitched into the nonwoven fabric. The sectional drawing of the stitching area (Fig. 2) shows the stitch-bonding elements participating in the forming of pile loops, and the media supplied.

1.4.1. Machine gauge and height of pile sinkers

The reference measure for all stitch-bonding elements in the Malimo stitch-bonding technique is 25 mm. Therefore, the machine gauge is given in number of needles or sinkers per 25 mm.

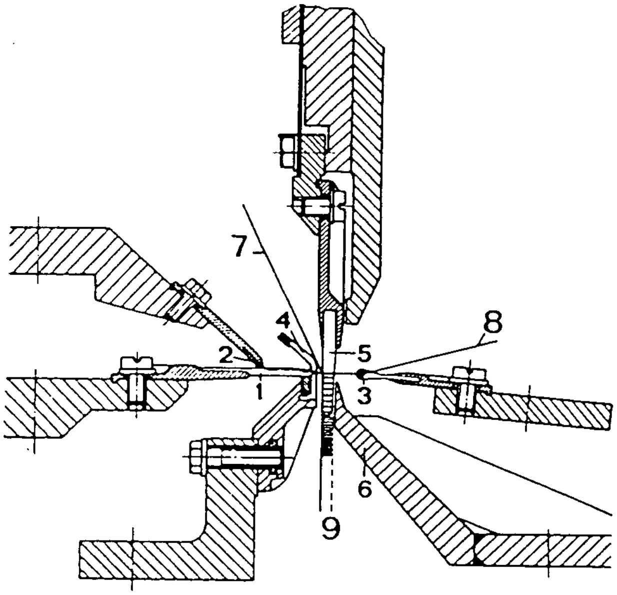


Fig. 2 Stitching area
1 stitching needle, 2 closing wire, 3 pile thread guide, 4 knocking-over sinker, 5 pile sinker, 6 front guide bar, 7 base fabric, 8 pile yarn, 9 stitch-bonded fabric

For the Malipol type the gauges 10 F, 12 F and 14 F exist. As shown in Table 2, all the pile sinkers having a height between 1 and 11 mm can be used for these machine gauges.

Table 2 Machine gauges and pile sinker heights

Stitching needle/ closing wire stroke in mm	15/12	17/13.6	24/13.6	Preferred pile sinker height
Gauge 10	1 - 2 - 3	4 - 5 - 7	9 - 11	5
12	1 - 2 - 3	4 - 5 - 7	9 - 11	4
14	1 - 2 - 3	4 - 5 - 7	9 - 11	3

If you have some experience in adjustment, the pile heights 1, 2, and 3 mm can also be produced with 17/13.6 cams.
When using the fine stitching needle in connection with pile heights from 1 to 3 mm, insert the cams 12/9.6 mm.

Table 3 Coarsest workable yarns

Machine gauge	Spun yarns		Twisted yarns	
	tex	(Nm)	tex	(Nm)
10 F	140	(7)	72 × 2	(14/2)
12 F	100	(10)	50 × 2	(20/2)
14 F	50	(20)	28 × 2	(36/2)

1.4.2. Stitch length and speed

The appearance of the article to be made is determined by the machine gauge, height of pile sinkers, and stitch length. The stitch length is adjustable from 0.7 mm to 5.0 mm by means of the change wheels delivered. Stitch lengths between 1 mm and 3 mm, however, are preferred. The speed, i. e. stitches per minute, is steplessly variable between 500 and 1500. Mainly speeds from 900 to 1300 stitches per minute are used.

1.5. Fabric take down and winding-up or plaiting mechanisms

The pile yarn stitch-bonded fabric is caught by the two-roller take down mechanism in the machine and doffed continuously in accordance with the stitch length setting, then passed over guide rollers and underneath the rear foot treadle to the fabric winding-up or plaiting mechanism. This mechanism, as already stated, may be supplied for winding or plaiting, or for winding and plaiting. The maximum diameter of the batch can be 1200 mm, provided that the admissible weight of 350 kg is not exceeded.

2. Production-technological possibilities of the Malimo type

2.1. Pile yarn

Suitable pile yarns are spun yarns and twisted yarns of cotton, wool, regenerated and synthetic fibres produced after the cotton, worsted, and woollen spinning methods, as well as continuous filament yarns. The workable yarn counts are given in Table 3.

The quality of the pile yarn has a decisive influence on the appearance of the finished article. When winding and warping the yarn, all irregularities must be eliminated.

For the process of stitch forming the pile yarn shall be soft and flexible. For dyed yarns, the use of softing agents is advisable.

2.1.1. Pile yarn take-up

For calculating the amount of pile yarn (g/m^2) required for 1 m^2 of pile fabric, determine the take-up ratio. The take-up ratio specifies, how many metres of yarn are required per metre of stitching considering the pile height and stitch length. The

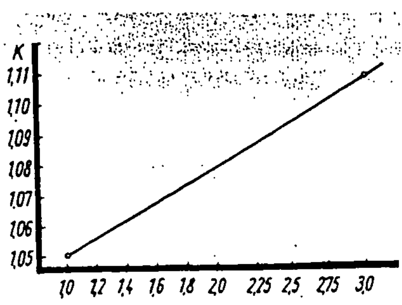


Fig. 3
Correction factor for the approximated determination of pile yarn – take up Stichlänge = stitch length

pile yarn taken-up may be determined by the following approximation calculation:

$$E_{Pl} = \frac{2\,St_L + 2\,P_H + 2\,G_D}{St_L} \cdot K$$

E_{Pl} = pile yarn take-up
St_L = stitch length in mm
P_H = pile height in mm
K = correcting factor
G_D = thickness of base fabric in mm

The correcting factor (Fig. 3) lies between 1.05 for a stitch length of 1 mm and a pile sinker height of 11 mm, and 1.108 for a stitch length of 3 mm and a pile sinker height of 1 mm. The machine gauge is negligible. For the determination of the pile yarn requirement in g/m², however, it is very important, as 400 threads per metre are required for the gauge 10 F, 480 for 12 F, and 560 for 14 F.

2.1.2. Determination of the pile yarn requirement

For a rough calculation of pile yarn requirement, determine the take-up according to section 2.1.1., fix the machine gauge and yarn thickness and calculate the weight of the pile yarn per square metre of grey fabric.

For a terry cloth off gauge 10 F having a pile height of 4 mm, a stitch length of 1.4 mm and a pile yarn count of 30 tex × 2, whose base fabric is a cotton fabric 0.74 mm thick, the pile yarn requirement is calculated as follows:

$$G\ (\text{g/m}^2) = \frac{Fd \cdot E_{Pl} \cdot \text{tex}}{1000} = \frac{400 \cdot 9.34 \cdot 60}{1000} = 223.92 \sim 224\ \text{g/m}^2$$

Fd = number of threads per metre (400 at a machine gauge of 10 F)
E_{Pl} = 9.34 1.062

When pile yarns of different thicknesses are used, calculate the portions separately and add them up.

2.2. Prefabricated textile fabrics as base fabrics

All the textile fabrics which permit piercing by stitching needles without impairment of cohesion, are suitable for base fabrics. Woven fabrics, for instance, must be constructed so that the warp and weft threads are only displaced on piercing by the stitching needles. Woven fabrics of twilled or satin construction are most suitable. Plain woven fabrics of a very low sett can also be processed. Furthermore, stitch-bonded thread layer fabrics and fabrics based on stitch-bonded fibre webs, foam materials, knit fabrics, plastic sheets, and similar materials are suitable. For terry cloths, mainly woven cotton fabrics and stitch-bonded fibre webs are used as base fabrics, for upolstery fabrics and blankets the base fabrics are of woven viscose fibre yarns, whereas for lining plushes and imitation furs fabrics woven of polyamide continuous filament yarns are used as a basis. Woven fabrics are most suitable in their unfinished or semi-finished state (e. g. optically bleached or pre-set)

Table 4

Gauge F	Stitch length St_L	Pile height P_H	Pile yarn		Weight of finished product	Output in metres per hour
10	1.6	4	cotton 30 tex × 2	cross twill 3/3 cotton 135 g.p.m²	370	70
14	1.5	3	cotton 50 tex	cross twill 3/3 cotton 135 g.p.m²	365	60
14	1.5	3	cotton 17 tex × 2	cross twill 3/3 cotton 135 g.p.m²	270	70

3. Some characteristic Malipol fabrics

The utility values of pile fabrics are a high tuft and pile bind, great voluminosity, and good heat retention. The special advantage of the Malipol technique may be seen in the fact that numerous material combinations are possible.

The properties of the finished product are predetermined by the appropriate selection of the base fabrics and pile threads, Malipol fabrics can be patterned in an interesting manner by using coloured pile yarns, different pile heights, or by dying, printing, raising, and embossing.

3.1. Stitch-bonded terry fabrics

Malipol terry fabrics are used for beach and leisure-time wear, baby items, hot pad covers, and bath-room sets.

3.2. Raised-pile fabrics

Raised-pile fabrics are fabrics the stitch sides of which have been raised to make better use of the pile material. During the first raising operations, the pile loop is drawn down to the fabric ground so that only a small portion of pile material remains on the reverse side. In this operation, the stitches are raised from the ground of the fabric so that they are easily engaged by the hooks of the raising machine. In addition to the roller-type raising machines with a high number of passages, which operate very gently and produce high-quality synthetic furs (noble fur imitations), table raising machines can be used as well.

Table 5

F	St_L	P_H	Pile yarn	Base fabric	Weight of finished product in g.p.m²	Output in metres per hour
synthetic fur for children's coats						
10	2 0	4	blended twisted yarn 138 tex 110 tex wool yarn 46 % wool 32 % viscose fibre yarn 22 % Elflafa 28 tex worsted yarn 100 % viscose fibre yarn	$K\,\frac{2}{2}$ viscose fibre yarn cotton 170 g.p.m²	530	80
High-pile imitations fur for ladies coats						
10	1 8	7	100 tex polyacrylonitrile fibre 30 % 7 den 70 % 15 den	$L\,\frac{1}{1}$ polyamide continuous filament yarn 50 g.p.m²	550	60
Upholstery material						
12	1 8	5	56 tex polyamide continuous filament yarn-crinkle	$K\,\frac{2}{2}$ viscose fibre yarn 118 g.p.m²	430	65

3.3. Noble fur imitations

The Malimo sewing-knitting machines type Malipol are excellently suitable for the production of synthetic noble furs such as mink, white squirrel, grey fox, and blue fox. It is advisable to use creels for pile yarn feeding as spun yarns and twisted yarns of three different counts have to be used. The staple lengths of the fibres, the fibre count as well as the pro-

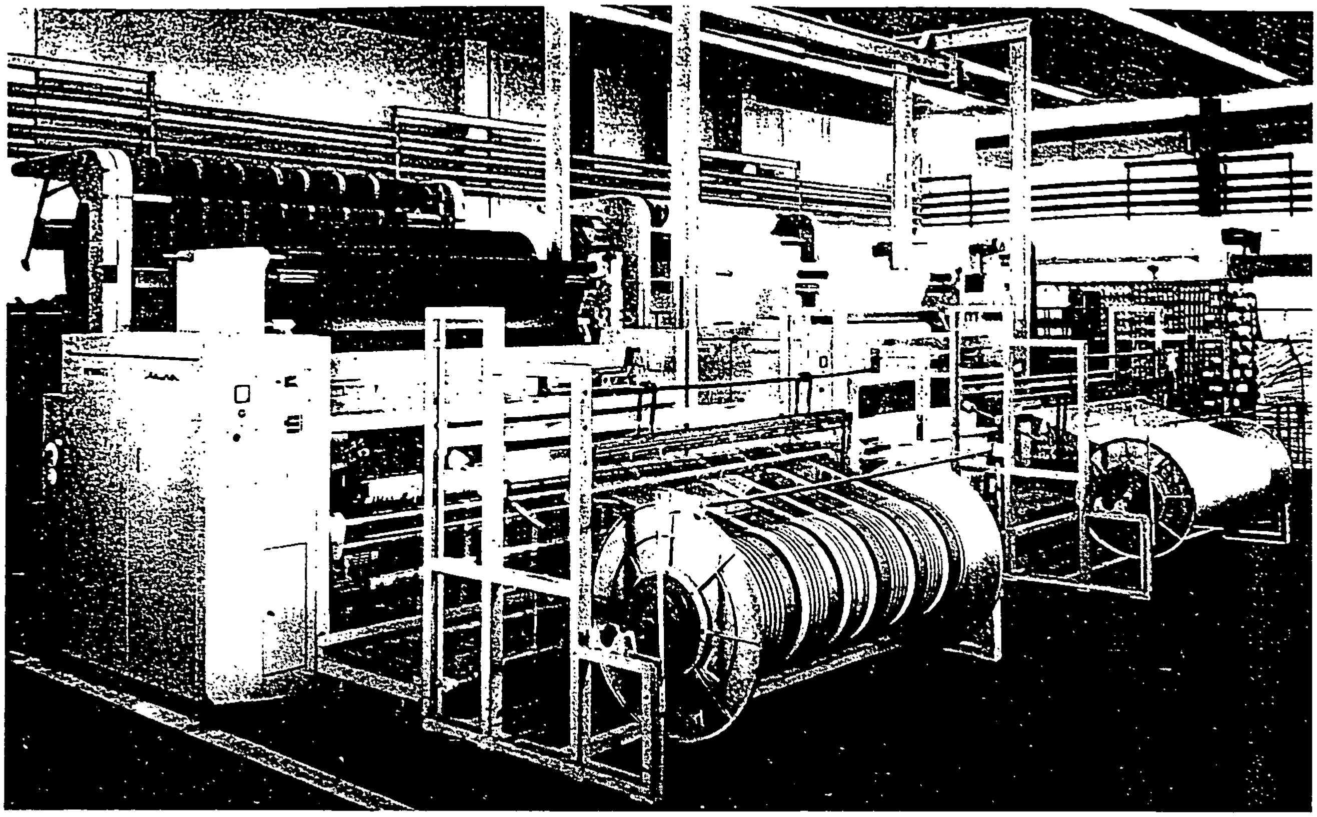


Fig. 4 Malimo sewing-knitting machines type Malipol – nominal width 1600 – for producing single-faced terry fabrics

portion of bristle hairs and shrinking fibres are to be selected according to the natural fur. Also the width of repeat depends on the fur that is to be imitated.

For imitated mink, woven fabric of polyamide continuous filament yarn having a weight per unit area of 40 to 50 g/m^2 was used as base fabric together with a polyacrylonitrile fibre yarn.

In the twofold yarn, the second thread contained a proportion of spun- dyed black coarse fibre. The same applies to the third of the threefold yarn. The individual threads were of count 125 tex.

The repeat in case of count 10 F was as follows:

8 threads single
1 thread twofold
1 thread single
8 threads twofold
1 thread threefold
1 tread twofold

8 threads threefold
1 thread twofold
1 thread threefold
8 threads twofold
1 thread single
1 thread twofold
total: 40 threads

These repeats may be varied in many ways, produced with coloured yarns, or piece dyed, or printed. In order to obtain a good raising effect, the spun yarns and twisted yarns shall only be twistet slightly.

3.4. Pile cutting device

A pile cutting device may be attached to the Malipol N 1600 machine to obtain velvet-type products. The device is suitable for machine gauge 10 F and pile heights of 5, 7, 9, and 11 mm. Spun yarns and twisted yarns of wool, cotton, viscose, and polyacrylonitrile fibre may be cut. Polyamide continuous filament yarns within the range of 23 tex × 2 to 5 tex × 2 may be cut.

The floor space required behind the winding-up mechanism is 1.5 m^2. The device is driven by its own motor within a power consumption of 2.2 kW. The life of the knives amounts to about 1 to 1.4 × 10^6 pile loops per knife. The prerequisite for an optimum life of the knife and a clean uniform cut is the employment of a knife grinding device.

Table 6 Pile loop density in N/cm^2

Stitch length	1,0	1.2	1.4	1.6	1.75	2.0	2.25	2.5	2.75	3.0
Gauge										
10	40.0	33.3	28.6	25.0	22.8	20.0	17.8	16.0	14.5	13.3
12	48.0	40.0	34.3	20.0	27.4	24.0	21.3	19.2	17.4	16.0
14	56.0	46.6	46.0	35.0	32.0	28.0	24.9	22.4	20.4	18.6

Striped patterns will be obtained by cutting or not cutting the pile loops rows at option.

4. Trends

Originally, the MALIMO sewing-knitting machine type Malipol had been designed for the production of floor coverings, first with a working width of 750 mm for carpet runner materials. In the meantime its fields of application have increased.

Recently there have again been endeavours to use the Malipol machine for making fine-pile floor coverings.

In parallel with the general development of the sewing-knitting technique, the Malipol type is also being further developed. If necessary, it will be possible to increase the working width; this, however, would be interesting only, if the proportion of floor coverings increased.

Speed will be increased and functional safety will grow so that the economy in producing pile fabrics, which already is good, will be improved further.

Part 6

Technical possibilities and technology of type Voltex

1. Description of the Voltex technique

The Malimo sewing-knitting technique, type Voltex, is a continuous stitch-bonding procedure and represents a technique in which nonwoven fabrics based on mechanically bonded fabrics are produced. It is characterized by the fact that unspun fibres are directly sewn into a prefabricated textile structure without any intermediate operational stage. In the process, stitches are formed and appear as stitch wales on the one side of the textile structure, whereas fibres are formed into tufts on its other side. Therefore, from the production-technological point of view, this process is called a pile web sewing-knitting method (PVN). The Voltex sewing-knitting machines and the corresponding technique are defined as follows:

Machine for the manufacture of stitch-bonded fabrics, equipped with transversely arranged and simultaneously moved needles as well as with means for stitch formation, feeding of the fibre web and feeding of textile structures.

Voltex technique: Technique for the manufacture of stitch-bonded fabrics, in which the surface of textile structures is modified by stitching-in fibres or monofilaments taken from a web, these fibres or filaments being formed into stitches on the one side of the fabric and into tufts on the other side of the fabric.

In line with the definition, the technique serves to modify textile structures and thus permits the conversion of simple woven cotton fabrics, monofilament webs etc. into high-grade textile structures (plush-or fur-like products, overcoat materials etc.).

Stitch-bonded fabrics of the Voltex type, on principle, are made of two elements, i.e., of the prefabricated base fabric and of a fibre web continuously fed to the stitching area.

In this technique, stitching threads, thread guides, yarn carriers such as tubes, warp beams etc. or preparatory processes such as winding, warping etc. are not required at all.

1.1. Working area and function

Figure 1 shows a sectional view of the working area of the Voltex type Malimo sewing-knitting machine. Its arrangement conforms to that of other Malimo sewing-knitting machines. The function of the stitching-needle/closing-wire system has been often described in literature, so that the reader is requested so refer to it. It should be underlined only that the stitching needles pierce into the continuously fed fibre web. seize the fibres, convert them into thread-like formations, and draw the latter – by means of pile sinkers – through the base fabric where they lay them off in form of stitches. Stitching or binding threads are not required as the so formed fibre strands function as tuft forming elements and, simultaneously, bond the tufts with the base fabric by stitching. The manufacturing scheme, Table 1, results from the product construction described. Its should be pointed out that just one production step is required to produce gray goods immediately from fibre material. This speedy production technique is reliable in operation, reduces losses, and is highly productive. As no threads are used for pile formation and, therefore, operations, losses, machine and space requirements involved in the preparation etc. are omitted, also post-ungrading and mending work is eliminated. Especially these departments normally have a high labour force requirement.

Figure 2 shows a Voltex production line. It always consists of the web-formation and sewing-knitting sections. Both sections are linked up with one another and are suitable for the implementation of the Voltex technique in their entirety only.

1.2. Web formation

The web formation in the Voltex technique should meet the following requirements:

a) Constancy of weight per unit area across the length and width, and over long periods of time;
b) Adjustability of the operating speed at otherwise unchanged parameters in the web forming section;
c) Workability of different fibres;
d) High operational reliability in web formation

At present, the Voltex technique is the only sewing-knitting technique in which unidirectional webs are processed without any intermediate stage. Owing to this feature, no cross lapper is needed and sewing-knitting machine and web forming machine are arranged in tandem.

Roller cards are especially suitable for the manufacture of unidirectional webs. They are easily adaptable to the requirements by the selection of the appropriate width, card clothing, working speed, etc.

The use of cotton-type cards is basically possible but, in practice, they are not used in conjunction with Malimo sewing-knitting machines, type Voltex.

Pneumatic web forming machines may also be applied under certain circumstances. In this case, however, a unidirectional orientation of the fibres has to be renounced and a relatively high random orientation must be accepted.

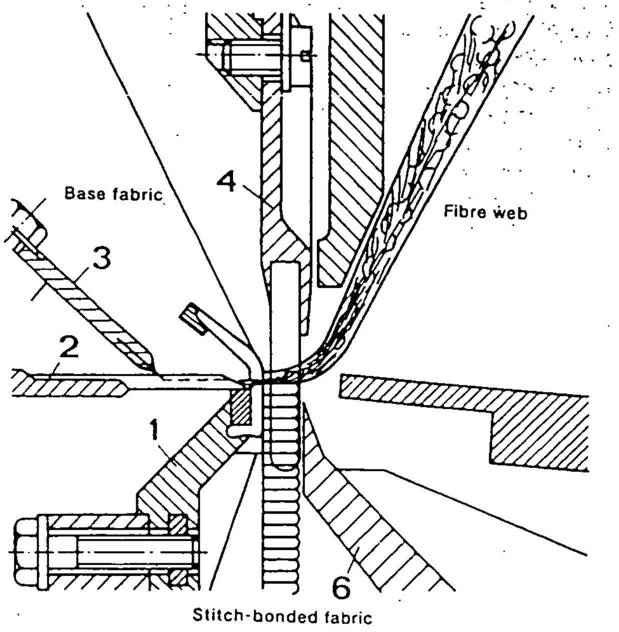


Fig. 1 Working area of a Malimo sewing-knitting machine, type Voltex
1 Knocking-over sinker units, 2 Stitching needle units, 3 Closing wire units,
4 Pile sinker units, 6 Front guide bar
7) Base fabric, 8) Fibre web, 9) Stitch-bonded fabric

Voltex production units involving roller cards are most widely used. Since the working width of the cards and the working width of the sewing-knitting machine have to be adapted one to the other because of the fact that unidirectional webs are processed, the following combinations result:

Working width of the sewing-knitting machine	1,600 mm
Working width of the cards	1,800 mm
Working width of the sewing-knitting machine	2,400 mm
Working width of the cards	2,600 mm

Type of card clothing and population of points depend upon the application envisaged. They should be selected so that different fibre deniers and fibre lengths can be worked up into perfect fibre webs on the same installation. In this connection, it should be pointed out that fibres of both different deniers and different lengths can be processed simultaneously without any problem in the Voltex technique. The reason for this peculiarity is that the web must be fed to the sewing-knitting machine without any draft and that, consequently, ,,places of incision" known from the manufacture of yarns under these circumstances, will not occur – an advantage which may be made use of in shaping the plush surface.

The population of points should be adapted to the ranges of fibre deniers envisaged. Take care at the same time to ensure that the required weight of web will be produced. Web uniformity and the opening of stock up to the single fibre have to be maintained in any case.

Both flexible and all-steel clothings may be used. If man-made fibres are worked up exclusively or primarily, all-steel clothings should be employed.

Table 1 Manufacturing scheme for Voltex products

Prefabricated base fabric
Continuously delivered web consisting of fibres or monofilaments
Malimo sewing-knitting machine, type Voltex
Voltex fabric

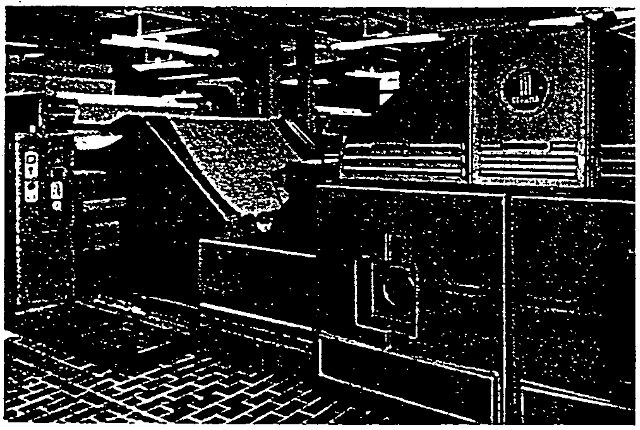


Fig. 2 Voltex production line

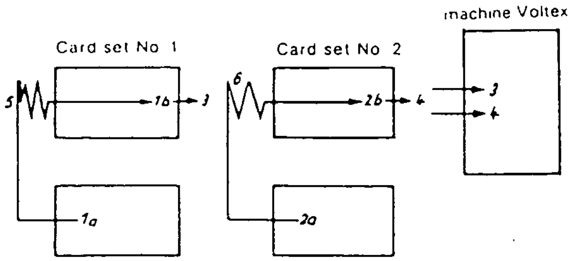


Fig. 3 Arrangement of a Voltex production line (standard version)

To ensure the constancy of weight per unit area, two-card sets have to be used, the second card being fed by a feed mat. Chute feeds cannot be used because the orientation of the fibres is changed and the fibres are fed to the second card in cross lay.

The required web weight of 40 to 80 g/m² has to be continuously produced by the fibre web former. These web weights are high for cards. For this reason, a normal Voltex unit (see Fig. 3) consists of:

2 two-card sets,
1 collecting unit and
1 Malimo sewing-knitting machine, type Voltex.

From the cards 1b; 2b a sheet of fibres each is taken off, the weight per sheet being 20 to 40 g/m². The conveying mechanism places one sheet on top of the other to form one web and feeds this web continuously to the sewing-knitting machine.

If it should be possible to get the required web weight from one two-card set only, the Voltex production line may be equipped so that one two-card set only is included (Fig. 2).

1.3. Malimo sewing-knitting machine, type Voltex

The structure of the Malimo sewing-knitting machine, type Voltex, conforms to that of other Malimo sewing-knitting machines. The adjustability of the sewing-knitting machine within the production line is of particular importance. Although the machine is connected to the lock-in circuit it must permit an infinite variation of the operating speed within narrow limits. This is necessary in order to avoid wrinkles or drafts in the web, which might be caused by minor differences in the card delivery because of the specific type of fibre, crimp, lubricant etc.

Should accumulations occur, too great an amount of web is fed to the stitching needles, open-type eyes of the stitching needles are torn off due to excessibe intermeshing forces. Web drafts, if any, will appear as thin places in the stitch-bonded fabric. Both types of defect cannot be remedied in the fabric produced and lead to reduced qualities.

2. Technological possibilities of the Voltex technique

Voltex products must always be manufactured on production lines. Discontinuous production with the webs wound up and separately fed to the sewing-knitting machine – is not possible. Such a production line can be characterized as follows (the version described here is based on one two-card set).

It should be underlined that the data given here are examples only. In case of actual prospects, we recommend to contact **VEB Nähwirkmaschinenbau Malimo**, Karl-Marx-Stadt, or the **Forschungsinstitut für Textiltechnologie**, Karl-Marx-Stadt, for advice.

Production line: It comprises one two-card set and one Malimo sewing-knittig machine, type Voltex.

Two-card set: For web formation, various card types may be used. However, they must be adapted to the requirements of the particular application. The use of compact-type cards is possible, too. Essential data:

Feeding: The two-card set is fed via a large-volume weighing hopper feeder, which delivers the fibres in a proportioned manner. Conveyance of the opened flocks to the weighing hopper feeder should be pneumatic.

Cross lap feed: This feed should be provided between the first and second cards of the two-card set as it will ensure a constant weight per unit area. The web is fed to card No. 2 by means of a Camel-Back appliance.

Chute feed should be avoided because the fibres would be fed transversely to card No. 2. Fig. 4 shows the principle of both transfer unit types.

Working width: See under item 1.2.; a web exceeding the working width of the sewing-knitting machine must be reduced in width by drawing off surplus fibre material already on the doffer and feeding it back to the weighing hopper feeder, This operation, at the same time, yields an even and straight web edge.

Number of workers/clearers: The number of workers/clearers depends upon the material to be processed. In case of man-made fibres, four workstations are sufficient.

Delivery: A web delivery of 8 to 20 metres/minute should be possible at the doffer of the second card. Otherwise – especially in case of great pile heights and, therefore, high consolidation in the sewing-knitting machine – the operating speed of the sewing-knitting machine has to be reduced too much. Under such circumstances, it is more favourable to work with two two-card sets.

Web weight: The web weight depends upon the product to be manufactured. It ranges between 40 and 80 g/m^2. Most of the Voltex units operate at 40 g/m^2. This heavy web has to be produced by card No. 2 at a constant rate of delivery.

Card clothing: The number of points per sq.cm of clothing should be selected so that a medium range of fibre finenesses, e.g. 0.34 to 2.2 tex, may be processed and the required web weight of 40 g/m^2 can be produced. Both flexible and all-steel clothing may be used, but all-steel clothing should be preferred in the processing of synthetic material.

Sewing-knitting machine: Malimo sewing-knitting machines, model 14010, are preferably applied. Table 2 contains the technical data.

3. Production-technological possibilities of the Voltex technique

As can be derived from the manufacturing scheme (Table 1), the Voltex products merely consist of the base fabric and fibres. All qualities owned by the final product have to be provided by these two components. This suggests that these qualities must be taken into account already in the selection of the components; likewise, suitable design parameters have to be considered. Since there is a great variety of possibilities as regards both components, if often depends on the textile technologist's skill to yield the desired effect by favourable manipulation.

Some instructions on materials and qualities typical of the Voltex technique are given here-below.

3.1. Base fabrics

The Voltex article to be produced substantially governs the selection of the base fabric to be used. On principle, base fabrics should be low in weight; the textile-physical values of the articles, however, must be guaranteed.

Due to the use of beard-type stitching needles, nearly all types of textile structures, whether woven, knit, stitch-bonded or made of slit films, can be processed. The weight per unit area may range between 40 and 200 g/m^2. In special cases, it may be of a higher value, too. Cotton yarns, cotton/VI-F yarns and man-made filament yarns are used as base fabric materials. Fabrics woven of sapes and monofilament webs of special constructions suit the purpose well. Use the base fabrics either treated with softeners or unfinished at all, since otherwise tensile strength reductions of about 50 % and more in transverse direction have to be expected.

3.2. Fibres

On principle, all fibres that can be converted into fibre web webs, can be processed into Voltex fabrics, i. e., both natural and man-made fibres.

There are no restrictions as to fibre fineness or fibre length so that fibres from 0.34 to 5 tex and from 38 to 150 mm long can be processed, even together, without any difficulties.

When wool is processed take care that it is carbonized beforehand. As in most cases just one two-card set is used, the few carding stations do not suffice for a complete cleaning. Piece-carbonizing, however, must be omitted because of the different rent fibre types mostly contained in the material.

The use of cotton type fibres (bt) is feasible, however, not common in connection with the Voltex technique. With a special view to the article appearance in case of plushes and fur imitations, the use of wool types (wt) should be generally preferred.

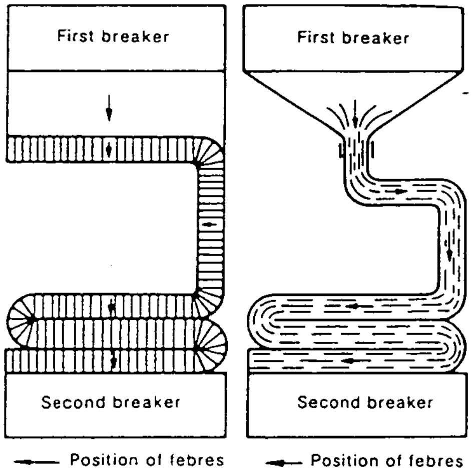


Fig. 4 Diagrammatic representation of cross lap feed and chute feed

Table 2 Technical data of the Malimo sewing-knitting machine, type Voltex, model 14010

Working width in mm	1,600 or 2,400
Machine gauge	preferably 10 F or 14 F
Pile sinker gauge	has to be adapted to the machine gauge; may be equal to the machine gauge, or the pile sinkers must be set in integer multiples of the spacing
Pile sinker height	It depends upon the stitching needle stroke used and can be selected within the range of 1 to 23 mm.
Stitching needle stroke	Stitching needle stroke and possible maximum pile sinker height are in correlation. The following combinations are possible at present: Stitching needle stroke, in mm — max. pile sinker height, in mm 15 — 5 17 — 7 24 — 13 26 — 15 34 — 23 The closing wire stroke and the wire motion should be set relative to the stitching needle strokes.
Length of stitch, in mm	0.55 to 5.0
Stitching needle version	medium-fine stitching needles, straight, angled, or double-angled. The use of other stitching needles such as coarse or fine ones, is possible on principle.
Operating speed, in stitches per minute	infinitely variable within the lock-in circuit from 500 to 1,500; 800 to 1,000 are common; operating speed depends upon length of stitch, pile sinker height and capacity of the cards used.

3.3. Textil -technological data

Machine gauge, length of stitch, pile sinker height, and the type of stitch, base fabric and web material are of decisive importance for the Voltex fabric. Their combination determines the final fabric appearance and the finishing procedure to be applied.

Machine gauge: It is directly related to the resulting fabric qualities. For instance, the tensile strength in transverse direction is reduced with an increasing machine gauge, with the other parameters remaining the same. On the other hand, a higher machine gauge yields a more uniform fibre coverage of the textile structure. It reduces, however, the applicable of the textile structure. It reduces, however, the applicable weight of the Voltex web.

In most cases, machine gauge 10 F or 14 F with a web weight of 40 g/m^2 are used.

Length of stitch: In connection with the machine gauge, it also has a bearing on the qualities of the products. Small lengths of stitch reduce the tensile strength in the transverse direction of the base fabric to a higher degree than great lengths of stitch. Like the higher machine gauges, small lengths of stitch lead to a more uniform coverage of the textile structure since the number of tufts per unit area increases. The tuft density results from the machine gauge and stitch length. The tuft density is computed by relation (1).

$$P = \frac{100}{St} \cdot 4 \cdot F \qquad (1)$$

P Tuft density/100 cm^2

St length of stitch, in mm

F Machine gauge, in needles/25 mm

If the number of pile loop legs is required, e. g. for raised goods, instead of the number of tufts, then this relation has to be multiplied by 2, as two loop legs are formed in every stiched hole.

In table 3, computed pile loop density values (in number of loop legs per 100 sq.cm) are given for machine gauges 7, 10, 12, 14 F.

The number of fibres intermeshed can be easily computed by means of these values, if the number of fibres per stitch or pile loop is known or counted.

Table 3 Pile loop density, in loop legs/100 cm^2

Machine gauge F	Length of stitch in mm 0.7	0.8	0.9	1.0	1.1	1.3	1.5	1.7	2.0
7	8.000	7.000	6.222	5.600	5.090	4.308	3.733	3.296	2.800
10	11.430	10.000	8.889	8.000	7.273	6.154	5.336	4.706	4.000
12	13.714	12.000	10.667	9.600	8.727	7.38[illegible]	6.400	5.647	4.800
14	16.000	14.000	12.444	11.200	10.182	8.61[illegible]	7.467	6.588	[illegible]

Pile sinker height: The maximum pile sinker height depends upon the stitching needle stroke. The combinations given under item 2. are common at present. It is possible, however, to operate the machine without necessarily using the maximum pile sinker height so that the pile sinker height of 7 mm can be combined with a stitching needle stroke of 17 mm and 24, 26, or 34 mm as well.

Consolidation ratio: The consolidation ratio of the Voltex web varies with increasing pile sinker heights. While the ratio is 7 to 8 : 1 at pile height of 7 mm, it can reach or exceed the value of 15 : 1 at pile heights of about 20 mm. This means that 7 to 8 or 15 m of Voltex web are needed for the manufacture of 1 m of grey goods.

The reason for the growing ratio is the increasing thickness of the grey goods when higher pile sinkers are used; it goes without saying that high-pile products (40 to 50 mm) can be made from these grey goods. Such products have, of cause, a remarkably higher weight per unit area.

Type of stitch: The combination of the machine gauge F with the suitable pile sinker gauge leads to different fabric surface appearances. Care must be taken, however, that the pile sinker gauge compared to the machine gauge should have certain constant values. This results in the combinations given in Table 4.

Table 4 Number of pile sinkers per 25 mm

Pile sinker gauge	Stitching needle gauge 10	12	14
$Pf = F$	10	12	14
$Pf = \frac{F}{2}$	5	6	7
$Pf = \frac{F}{3}$		4	-
$Pf = \frac{F}{4}$	2.5	3	3.5

By means of these combinations, V-type, W-type, and double W-type stitches can be produced. The least obvious rib is formed with $Pf = F$. In case of $Pf = \frac{F}{2}, \frac{F}{3}$ or $\frac{F}{4}$ an ever growing lengthwise marking results. Figure 5 shows cross sectional views of these types of stitch. Stitches of the types

$$Pf = \frac{F}{2}; \frac{F}{3}; \frac{F}{4}$$

etc. are of interest substantially for articles in which the surface structure of the grey goods is maintained, i. e. not subjected to raising treatment. A very firm locking of the fibres is achieved. For patterning purposes, the pile sinkers can also be placed under other aspects.

Base fabric: It is especially important for the tensile strength of the finished article. The base fabric has to be selected for each article concerned under the aspect of the damage to be expected as well as in conformity with the instructions given under item 3.1.

Type of fibre to be used for the Voltex web: The properties of the fibres used decide on the qualities of the article – hence fibre selection must be done accordingly.

Since all fibres can be processed without difficulties, no restrictions result in this respect. It is particularly advantageous that highly different fibres can be worked up simultaneously. This is of importance in the manufacture of imitations furs.

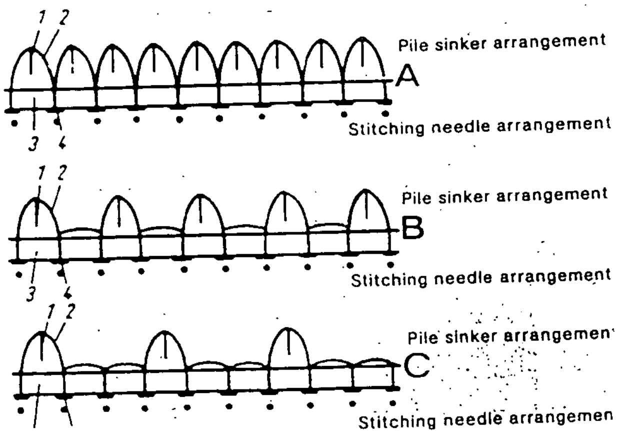


Fig. 5 Types of stitches used in the Malimo sewing-knitting technique, type Voltex

Pile sinker arrangement	Type of stitch
A Pf = F	U-type
B Pf = F/2	W-type
C Pf = F/3	Double-W type

1 Pile sinker, 2 Tuft (or pile loop), 3 Base fabric, 4 Needle wale

Table 5 Density of air cushions contained in air pockets/100 cm^2
(Assumption: 20 fibres per pile loop element)

Machine gauge F	Length of stitch, in mm								
	0.7	0.8	0.9	1.0	1.1	1.3	1.5	1.7	2.0
7	160,000	140,000	24.440	112.000	101.820	86.160	74.660	65.920	56 000
10	228.600	200.000	177.780	160.000	145.460	123.080	106.660	94.120	80.000
12	274.280	240.000	213.340	192.000	174.540	147.700	128.000	113.940	96.000
14	320.000	280.000	248.880	224.000	202.640	173.200	149.340	131.760	112.000

Patterning potential: Apart from the possibilities of shaping the fabric surface by V-type and W-type stitches, in addition, pile sinkers of different heights can be arranged one aside of the other. Patterning by blending is primarily applied.

Fibre blends can be combinations of different colours, types of fibres, fibre deniers and lengths of fibres. In most cases, combinations of these possibilities are made use of. Furthermore, it is possible to feed coloured rovings in addition so as to obtain a lengthwise pattern that is well tuned in colours. When working with multi-layered webs (Voltex installations including two two-card sets), every layer can be designed in conformity with the aforesaid possibilities.

Furthermore, Voltex fabrics can be patterned by means of raising machines. Different pile heights can be obtained by the use of stencils or controlled lifting of the shearing blades. Apart from this, patterning is possible by precise friezing of the pile (ratteening effects), tumbler processes, and pressure and brushing treatments.

3.4. Applications

The Voltex technique, basically, is a technique for the manufacture of voluminous textile structure, i. e. of pile fabrics or products having a plush surface. This premise is decisive for the products' applications. These products are mainly plush-like inside linings, fur-like outerwear and plushes for toys, shoe upper materials as well as shoe lining materials.

In utilizing the textile-technological possibilities at hand, the manufacture of both imitation furs and of longitudinally textured floor coverings in W-type or double-W-type stitches are possible.

Upolstery fabrics can be manufactured when pile sinkers of different heights are used.

An application of special importance is the manufacture of blankets with plush-character on both sides: they consist of 100 % unspun fibres. Their manufacture by means of continuous production lines is extraordinarily economical.

Cloth-like ladies' and men's overcoat materials can be produced, if fibres suiting this purpose are used and the appropriate machine parameters are selected. By a proper selection of the finishing treatment, the surfaces can be made pileless, textured or bristly-hair-like. The above-mentioned applications represent wide fields. It is beyond the scope of this paper to deal with individual assortments in detail. The Voltex manufacturers all over the world, however, produce a great variety of different articles and permanently work on the development of new articles and the opening-up of new applications.

3.5. Properties

The values for the tear strength in longitudinal and transverse directions, absorption and transfer of moisture etc. are decisively influenced by the properties of the base fabric and the fibres formed into the pile. Having this in mind, the appropriate fibres and base fabrics have to be selected for the applications concerned.

Outstanding heat retention is a property that is typical of Voltex products. The reason for this is the fact that the Voltex fabric fibres stand individually and are locked so in the base of the fabric; they are not twisted one with the other. Thus a multitude of small voids results in which air is retained that effects the high thermal insulation. Using the pile loop density contained in Table 3, the number of pockets filled with air can be calculated. Assuming that 20 fibres are contained in every loop element – a number that depends upon the fibre denier, web weight etc., on average, however, corresponds to the effective values – then the number of air cushions results as is shown in Table 5.

Hence, at least ~ 107,000 and maximum 224,000 such pockets/dm^2 or from 10.7 to 22.4 per mm^2 exist, related to the parameters mostly used (10 to 14 F and 1.0 to 1.5 mm length of stitch). The pockets located between the individual piercings have to be added.

This remarkable air inclusion effects that, above all articles for clothing purposes can be made which are lower in weight and, nevertheless, have the same heat retention capacity – an advantage that increases the comfort in wearing these garments and is of great importance in the manufacture of blankets.

Because of the nearly vertical arrangement of the individual fibres in the base fabric (they are not twisted one with another) stitch-bonded pile fabrics are insensitive to pressure. The reason of this phenomenon is based on the fact that the fibres are primarily strained in their longitudinal axes.

4. Summary

The Malimo sewing-knitting technique, type Voltex, is a continuous process for manufacturing voluminous textile structures. Due to the simple manufacturing procedure, the continuous lines are extremely failure-resistant and, therefore, of a high output. As the manufacture of grey goods from fibre webs and base fabrics requires but one operation, the losses in textile fibres, the space requirement, power consumption, and number of labour force are extraordinarily low. Repair and mending operations are completely omitted, a fact which contributes to the economy of this technique.

In the finishing department, too, continuous lines can be installed as is done in the manufacture of the Voltex fabric. To this end, pile raising machines, pile electrifiers and shearing machines, which best suit the requirements of plush-or fur-like products, are used.

For the base fabric, all kinds of textile structures may be used. Since slit film, tape, monofilament webs etc. can also be used as a substrate, combinations with the fibre material result which can be realized by the Voltex technique only.

Both natural and man-made fibres can be used. Preference should be given to material dyed in grain in order to avoid wet processes after grey good manufacture.

Due to the specific structure, voluminous, plush-or fur-like products are produced primarily. With an appropiate choice of the finish and the use of a material selected toward the end-use requirements, at present, plushes for toys, plush-like inside lining materials, outerwear and overcoat materials, blankets, and imitation furs are preferably produced. Floor coverings with a distinct rib structure can also be manufactured.

The development work on the Malimo sewing-knitting technique, type Voltex, is continued – above all as regards the operating speed, web formation and applications.

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